

The Journal of the Foundation for Science and Technology (formerly Technology, Innovation and Society)

Volume 19, Number 6, November 2007

Managing risk

Rick Haythornthwaite: Risk, responsibility and regulation Sir David Omand: Risk management – an audit of Government

Biofuels

Lord Oxburgh: The good, the bad and the not so bad Sir Howard Dalton: Preserving agricultural diversity – the role of second-generation biofuels

Ingmar Juergens: The way forward - a global view

Innovation

Jonathan Kestenbaum: Five habits of innovative societies Anne Glover: Connecting innovation and business success Peter Warry: The role of research councils in improving UK performance Professor Rod Coombs: How the universities can contribute more effectively

The Energy White Paper

Willy Rickett: The challenge of securing secure and sustainable supplies of energy

Barry Neville: The UK needs a market-based approach to energy policy Dr John Miles: The challenges on the demand side

Government changes

Sir Keith O'Nions: The framework for supporting research and innovation Phil Willis: The reorganisation – challenges and opportunities Lord Broers: Staying at the forefront of innovation





THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

Registered Charity No: 274727. A Company Limited by Guarantee No: 1327814

PRESIDENT

The Rt Hon the Lord Jenkin of Roding

VICE PRESIDENTS

The Earl of Shannon The Lord Flowers FRS Sir Brian Jenkins GBE

COUNCIL

CHAIRMAN The Earl of Selborne KBE FRS

The President of the Royal Society The Lord Rees of Ludlow OM PRS HonFREng The President, The Royal Academy of Engineering The Lord Browne of Madingley FREng FRS The President, The Academy of Medical Sciences Professor John Bell PMedSci The President, The Science Council Sir Tom McKillop FRS FRSE FMedSci Chairman, The Engineering and Technology Board Sir Anthony Cleaver Chairman, The Arts and Humanities Research Council Professor Sir Brian Follett FRS Chairman, The Biotechnology and Biological Sciences Research Council Dr Peter Ringrose Chairman, The Economic and Social Research Council The Lord Turner of Ecchinswell Chairman, The Engineering and Physical Sciences Research Council Mr John Armitt CBE Chairman, The Medical Research Council Sir John Chisholm FREng CEng FIEE Chairman, The Natural Environment Research Council Mr Edmund Wallis FREng Chairman, The Science and Technology Facilities Council Mr Peter Warry FREng Chairman, The Technology Strategy Board Dr Graham Spittle

Sir Michael Atiyah OM FRS PRSE Professor Polina Bayvel FREng The Lord Broers FRS FREng Sir Geoffrey Chipperfield KCB Sir Graeme Davies FRSE FREng The Lord Haskel Dr Geraldine Kenney-Wallace FRSC The Lord Krebs FRS FMedSci Sir Hugh Laddie The Baroness O'Neill of Bengarve CBE PBA Sir Rob Margetts CBE FREng The Lord May of Oxford OM AC Kt FRS FMedSci The Lord Oxburgh KBE FRS HonFREng The Lord Soulsby of Swaffham Prior FMedSci The Lord Sutherland of Houndwood KT FBA FRSE Dr Mark Walport FMedSci The Baroness Wilcox Sir Peter Williams CBE FRS FREng

Dr Robert Hawley CBE DSc FRSE FREng (Deputy Chairman) Mr Patrick McHugh (Honorary Secretary) Mr Tony Quigley (Honorary Treasurer)

CHIEF EXECUTIVE

Dr Dougal Goodman FREng

Neither the Foundation nor the Editor is responsible for the opinions of contributors to FST JOURNAL. © 2007 The Foundation for Science and Technology. ISSN 1475-1704

The Foundation for Science and Technology 10 Carlton House Terrace London SW1Y 5AH

Telephone 020 7321 2220

Fax 020 7321 2221

e-mail fstjournal@foundation.org.uk

> Editor Sir John Maddox FRS

Sub-editors Wendy Barnaby, Judy McBride, Simon Napper, Charles Wenz

> Production & Layout James McQuat

www.foundation.org.uk





THE COUNCIL OF THE FOUNDATIONinside front cover
UPDATE
Government Office for Science, new GCSA, departmental scientific advisers, new head of the MRC, engaging with schools, Government acts on Sainsbury Review, the Technology Strategy Board, supporting careers in research, lessons about avian flu
COMMENT
Is a consensus among scientists enough for politicians? <i>Archimedes</i>
MANAGING RISK
Risk, responsibility and regulationRick Haythornthwaite5
Risk management: an audit of Government <i>Sir David Omand</i> 6
BIOFUELS
The good, the bad and the not so bad Lord Oxburgh
Preserving agricultural diversity: the role of second-generation biofuels Sir Howard Dalton
The way forward – a global view
Ingmar Juergens10
INNOVATION
Five nabits of innovative societies
Connecting innovation and business success
Anne Glover 13
The role of research councils in improving UK performance
Peter Warry
How the universities can contribute more effectively
Professor Rod Coombs
THE ENERGY WHITE PAPER
The challenge of ensuring secure and sustainable supplies of energy
Willy Rickett
The UK needs a market-based approach to energy policy
Barry Neville17
The challenges on the demand side <i>Dr John Miles</i>
GOVERNMENT CHANGES
The framework for supporting research and innovation
Sir Keith O'Nions
The reorganisation: challenges and opportunities Phil Willis MP
Staying at the forefront of innovation
Lord Broers
The new departments

New head of the MRC

Professor Sir Leszek Borysiewicz, FRCP FRCPath FMedSci, was appointed Chief Executive and Deputy Chair of the Medical Research Council (MRC) on 28 September. Professor Sir Leszek Borysiewicz is Deputy Rector at Imperial College London, having joined the College in 2001 as Principal of the Faculty of Medicine. Previously he was Professor of Medicine and Head of the Department of Medicine at the University of Wales, Cardiff.

In his current role at Imperial, Sir Leszek has been responsible for the overall academic and scientific direction of the College, particularly the development of inter-disciplinary research between engineering, physical sciences and biomedicine. As a physician Sir Leszek specialises in viral immunology, infectious diseases, cell mediated immunity, virus associated malignancy and vaccine development. He is the author of reports for the World Health Organization, the Medical Research Council and the Department of Health. He has also chaired the Department of Health research advisory committee collating research on Creutzfeldt-Jakob Disease. He was knighted in the 2001 New Year's Honours List for his research into developing vaccines, including a vaccine to prevent the development of cervical cancer.

Sir Leszek was a founding fellow of the Academy of Medical Sciences in 1996. He is Chairman of HEFCE's main Clinical Medicine panel for RAE 2008. He was a member of the Council of Cancer Research UK from 2002 to 2005 and a governor of the Wellcome Trust from 2006 to 2007. He is also currently joint chairman of the MRC/UK Stem Cell Foundation Scientific Advisory Board.

Innovation Adviser

Peter Davidson became the Government's Senior Innovation Adviser on 1 October.

He will provide advice on all aspects of business innovation – primarily to the Department for Business, Enterprise and Regulatory Reform (BERR) and the Department for Innovation, Universities and Skills (DIUS) – but also more widely across Government, as required.

Reporting in BERR to Vicky Pryce, Chief Economic Advisor, and in DIUS to Sir Keith O'Nions, Director General of the Research Councils, Mr Davidson will strengthen links between the two Government departments and business sectors. He will work with teams in both departments to review areas of innovation opportunity, and to identify gaps in current innovation policy programs and strategy.

Government Office for Science

A Government Office for Science, headed by the Government Chief Scientific Adviser (GCSA) Sir David King has been created within the Department for Innovation, Universities and Skills (DIUS), reporting to the Prime Minister and Cabinet.

The Government Office for Science takes over the functions and resources of the Transdepartmental Science and Technology Group of the Office of Science and Innovation, which was within the former Department of Trade and Industry.

The GCSA and Head of the Government Office for Science will be responsible for:

• providing scientific advice personally to the Prime Minister and members

Departmental Science Advisers

Professor Robert Watson has been the Chief Scientific Adviser for the Department for **Environment, Food and Rural Affairs** (Defra) since September 2007. He is ultimately responsible for the broad range of science that falls under Defra's remit. His main role is to provide ministers with the best possible scientific advice and build on existing measures to ensure that science and technology are used to inform policy. He also supports the UK Government's scientific work on minimising the effects of climate change and improving sustainability by promoting consistency across Defra and working together with other Government departments.

From 1997 to 2002, he was Chair of the Intergovernmental Panel on Climate Change (IPCC), and from 1991 to 1994, he served as Chairman of the Global Environment Facility (GRF) Scientific and Technical Advisory Panel. of the Cabinet (in consultation with Departmental Chief Scientific Advisers when appropriate);

- advising the Prime Minister and Cabinet on aspects of Government policy on science and technology;
- ensuring and improving the quality and use of scientific evidence and advice in Government;
- leading the science and engineering profession within the Civil Service.

The other elements of the former Office of Science and Innovation (OSI) have become part of the DIUS Science and Innovation Group, headed by Sir Keith O'Nions as Director-General (see pages 20–24 of this issue).

Professor Brian Collins of Cranfield University is the new Chief Scientific Adviser (CSA) at the **Department for Transport**. Professor Collins succeeded Professor Frank Kelly from 2 October and works on a part-time basis.

Professor Collins is currently Professor of Information Systems and Head of Department at the Defence College of Management and Technology (DCMT), Cranfield University. He is the DCMT academic leader for all ICT research and education where his research centres on information management using next generation information and communication technology (ICT). His early career was in the scientific civil service culminating as Chief Scientist at the Government Communication Headquarters. He then worked in the private sector at KPMG, Wellcome Trust and finally as Chief Information Officer for Clifford Chance.

Engaging with schools

The Government has challenged universities to identify and nurture young talent in the UK from the earliest stage, widening participation in higher education through closer engagement with academies and new trust schools.

Speaking at University College London (UCL), John Denham, Secretary of State for Innovation, Universities and Skills, and Schools Minister Lord Adonis, launched a detailed prospectus urging universities to become engaged directly in schools and academies.

The prospectus makes clear that universities will be able to sponsor academies without needing to provide the usual £2 million sponsorship contribution. It sets out three ways in which universities can involve themselves in the management of secondary schools:

- settting up, sponsoring and managing their own academies;
- supporting an academy as a co-sponsor, bringing educational expertise;
- partnering a trust school maintained by a local authority in order to help it expand or enhance its provision.

The prospectus outlines ways in which universities can offer academies benefits including a strong educational vision for the school in addition to robust governance and leadership. Universities can also provide professional development for teachers, support and mentoring for pupils as well as developing a specialist curriculum. **www.dius.gov.uk/publications/prospectus.pdf**

Government acts on Sainsbury Review

The Government has accepted the recommendations of the review of the UK's science and innovation system carried out by Lord Sainsbury and published on 5 October. It is pledging to invest £1 billion over the coming three years to boost business innovation and technology development. It will create "a new science and innovation strategy" to help position Britain as a key knowledge economy "at the forefront of 21st century innovation".

Lord Sainsbury's review will be used as a blueprint for the process. He was science and innovation minister from 1998-2006. The new science minister at DIUS, Ian Pearson, will be be responsible for the implementation of the Sainsbury review, having taking over the mantle from Malcolm Wicks.

The review finds Britain has significantly improved its innovation performance in recent years, but still needs to do more to produce the best possible conditions to stimulate innovation in industry.

Among the announcements from the Government in response to the Review are:

- A new £1 billion package of support for technology and innovation in business;
- The development of a detailed strategy for science and innovation by the Department of Innovation, Universities and Skills (DIUS);

The Technology Strategy Board

• New measures to improve further

The Technology Strategy Board became established as an executive Non-Committee and Chair, Business and Industry Panel at the Engineering

Departmental Public Body (NDPB) with effect from 1 July. On 19 September, a new Chief Executive was appointed. Technical Board (ETB). Mr Gray takes up his new, full-time appointment, on 1 November.

The Board is sponsored by DIUS, and has a cross-Government role, advising on polices which relate to technology innovation and knowledge transfer and in delivering a national Technology Strategy.

Lessons about avian flu

Iain Gray is currently Managing

Director and General Manager Airbus

UK and Head of A380 Wing. He is a full

council member of the Royal Aeronautical

Society, a Member of the CBI's President's

Defra has published a 'lessons learned' report following the outbreak of H5N1 highly pathogenic avian influenza in Suffolk in February this year. The report concludes that the response to the outbreak was effective and highlights the benefits of the contingency planning work over the last six years. Disease was contained to one premises and controlled quickly and successfully.

The report also makes 34 detailed operational recommendations on the management of an outbreak of avian influenza, or other exotic animal disease. These recommendations have all been accepted and have already been adopted in response to the current Foot and Mouth Disease and Bluetongue outbreaks.

The recommendations include:

- a need to work ever more closely with other involved parties and the livestock industry on disease control activities;
- animal health agencies need to work with industry to ensure plans are in place at every large commercial poultry premises;
- animal by-product arrangements should be reviewed and strengthened for premises similar to the Holton site;
- communications need to be fast and effective, and focussed on key audiences.

the teaching of science, technology, engineering and mathematics (STEM) subjects;

- Improved knowledge transfer between the research base and business through an improved Higher Education Innovation Fund, building up support for business-facing universities, and a doubling of the number of Knowledge Transfer Partnerships;
- Better support for early-stage hightechnology companies through a reformed Small Business Research Initiative with more effective use of Government procurement to drive business innovation, a national 'proofof-concept' fund, and the support of RDA for incubators, high-technology clusters and business readiness services;
- Increasing international collaborations to help attract researchers from abroad and link British researchers with the best and brightest researchers globally.

DIUS will produce an annual Cross-Government Innovation Report. This will report on the innovation activities of DIUS, including the Technology Strategy Board (TSB), other government departments and the Regional Development Agencies.

reviews/sainsbury_review/sainsbury_index.cfm

www.hm-treasury.gov.uk/independent_

Supporting careers in research

A report by the Council for Science and Technology (CST) has recommended reform of the current early career structure for researchers in the UK. *Pathways* to the future: the early career of researchers in the UK* identifies two key areas:

- There is a need for a national framework for research careers. The report says: "Not only must such a framework show how a career can progress in academia, but also how it prepares people for transitions to jobs in other sectors. The role of the Principal Investigator as an effective line manager has been much neglected and should be supported to a greater extent. We urge funders, together with other bodies, to consider the incentives that could be put in place to encourage the uptake of a new system."
- Research staff must be allowed greater independence at an earlier stage so they may take on greater responsibility for projects and staff. The Council's report suggests: "the use of research fellowships can play an important role and should be used more widely: personal *ad hominem* fellowships allowing researchers greater freedom to move between institutions and fields; and institutional fellowships, whereby a researcher is attached to a department of a university and deployed within that unit rather than attached to a specific funded project."

A central issue, says the CST, is how universities think of their staff. It says there must be a change of mindset from Higher Education Institutions, arguing that "early career research staff should be properly treated as employees and given appropriate back-up for their staff development requirements".

Research Councils UK (RCUK), the body representing the seven research councils, welcomed the report. It said a Revised Concordat to support the career management of researchers is being developed.

The Research Councils recently announced the investment of over £15 million in a new researcher development programme to enhance the quality and output of the UK research base through training world-class researchers.

A Careers in Research website, developed in collaboration with the Wellcome Trust and the Royal Society will be launched shortly, said RCUK. It will be aimed at PhD and early post-doctoral researchers, providing the support and advice they need.

The Foundation held a meeting on this subject on 7 February. See www.foundation.org.uk

*www2.cst.gov.uk/cst/reports/files/sciencegovernment/cst_pathways.pdf

Is a consensus among scientists enough for politicians?

Archimedes

A cademics often despair – there is, they say, a 'scientific consensus' on housing/crime/transport/health, yet ministers follow or produce policies taking no account of it. The issue raises two fundamental questions: what is the nature, or function, of 'scientific consensus'; and how does it relate to policy decisions.

These questions have been pursued recently in a series of articles and letters in the *Financial Times*. Michael Schrage wrote an article entitled *Science Must be More Political* in which he urged ministers to be more critical of scientific consensus (a dubious concept, he argued). He suggested that scientists also need to be more accessible, while at the same time aware of uncertainties in consensus and the ethical, cultural, economic and political factors which must go into policy decisions – in short, be more political.

Lord Rees believed that Schrage had failed to recognise the difference between science and politics, thinking instead that politicians were free to treat science as negotiable, choosing which scientific view to adopt 'on whim'. "Scientific consensus may be provisional – but [not] all imaginable views are equally deserving of attention," he wrote. John Kay thought the term consensus was misused; it was itself obtained by political means - negotiation and compromise. "We do not say," he wrote, "that there is a consensus over the second law of thermodynamics – that is the way things are. Nor is there a consensus on evolution since creationists will never be reconciled to that theory. Science is a matter of evidence, not of what the majority of scientists think ... If all the members of the Royal Society [were converted] to creationism that neither would nor should affect my belief in evolution." David Read, of the Royal Society, thought Kay's views meant that scientists should be confined to their laboratories until a fact were conclusively proven. "Science draws closer to truth over time – scientific consensus is based on the evaluation of existing evidence."

Finally, Professor Davies pointed out that science relating to, say, climate change is complex and not understandable by the public or politicians, but the consensus is strong and decisions need to be taken now. The Royal Society, on behalf of that scientific consensus, must advise ministers of the consequences of not taking decisions.

These exchanges do little to help the

beleaguered decision taker. Take, for example, a minister being pressed to spend millions of pounds on flood defences because climate change means that sea levels will rise. Let us hope he asks for the scientific evidence. He is told there is a scientific consensus that climate change is occurring. No doubt he should ask how this consensus came about. Are all scientists in agreement? He would be told about the Intergovernmental Panel on Climate Change (IPCC). No matter how tortuous the IPCC negotiations were, there is, as Professor Davies says, a 'strong' consensus. But then he should ask, does climate change affect sea levels around the UK?

... what is the nature, or function, of 'scientific consensus'; and how does it relate to policy decisions.

The consensus is, perhaps, less strong on this. He needs an explanation as to why some (perhaps 'rogue') scientists disagree. Next, what is the scientific view on the level of sea rise? He might then be told that, say, there is a consensus that it will rise around the UK about 25cm in 10 years. But this consensus hides a range – some think 10cm, others 40cm. The consensus is only a mean – a 'weak' consensus, perhaps. But can he ignore it, as John Kay suggests, or must he accept it as 'provisional' as Lord Rees implies?

The answer is, surely, neither; he must first seek to have it evaluated, and then look at the consequences. He needs intelligible advice on why some think 10cm and others 40cm, but 'most' or the 'best' scientists would sign up to 20cm. He needs to understand the arguments he can deploy if he decides on 20cm and is accused, therefore, of threatening to drown the Romney Marsh. Finally, he needs to decide whether to raise the sea wall, or raise the beach level. On this there may be no scientific consensus at all, but only different views from different scientists. But he still needs scientific advice.

So the simple advice that there is a 'scientific consensus' is of little help. A minister must be told about the nature of the consensus, how it came about, who disagrees, and why. The influence on his decisions depends on the evaluation of the consensus. He cannot, or should not, ignore even a 'weak consensus'. Where there is a 'strong consensus' – as in John Kay's delightful example of all members of the Royal Society becoming creationists – it should become the strongest factor in his decision (even if Kay has not changed his mind).

In the example given, the influence of the consensus becomes less as we move through the chain of decisions. In the end, it may be minimal.

But, of course, as Michael Schrage said, the scientific advice is not the end of the story. The minister must consider: culture, environment and history (the uniqueness of the Romney Marsh site, Roman remains, birds); ethics (displacing populations); law (human rights must come into it somewhere); politics (whether Romney Marsh votes Labour or Conservative); as well as finance – building sea defences for a10cm rise may cost £300,000 million, building for 20cm £600,000, building for 40cm £4 million.

The eventual decision may well, therefore, not accord with the scientific consensus. It is much less likely to do so if the scientific advice is not intelligible to a layman, does not accurately reflect the strength or weakness of the 'consensus', and does not take into account that the minister must consider other values ...which is what I understand Michael Schrage to mean by scientists becoming more political.

So policies may not follow 'scientific consensus' because of the nature of that consensus, its clarity and intelligibility, or its conflict with other factors. But, alas, a very frequent reason is that the decision maker either did not ask for, or was not given, scientific advice. It is the failure of ministers or administrators to seek scientific advice, or understand it when offered, that is the real problem.

Archimedes is an experienced observer of the evolution of public policy who contributes occasional comments on topical issues. The Government has regularly been challenged over the way in which risk is managed in policy and regulation. A joint meeting of the Foundation for Science and Technology and the Hazards Forum on 9 May 2007 examined the progress being made.

Risk, responsibility and regulation

he Better Regulation Commission's report *Risk, Responsibility, Regulation: Whose Risk Is It Anyway?* sets out to stimulate a public debate about the management of risk by individual citizens, the media and Government. Our own views on risk change from day to day and from group to group. The Better Regulation Commission asks policy makers to consider the issues that govern our perceptions of risk and asks society as a whole what we expect Government to do about risk. There is an inseparable balance between risk and regulation.

The Commission is seeking the most effective way to reach an agreed policy outcome, partly by reducing red tape but increasingly through rethinking how we regulate to manage risks. We advocate a balanced approach to policy making, wanting society to consider the trade-offs involved in the decisions made.

In Whitehall, there are many good examples. Consider the collapse of Farepack before Christmas 2006: the company had collected contributions from members of the public against the promise of Christmas hampers, but proved unable to deliver. The political need to protect the vulnerable could have been met by a knee-jerk reaction – perhaps by throwing money at the problem. Instead, the Government took time to consider the matter and drew up a voluntary code of practice to regulate such happenings.

Similarly, the Food Standards Agency dealt sensibly, in the aftermath of the BSE crisis, with the regulation that prevented farmers sending to market cattle older that 30 months. Impressively, the agency reached a tough decision by means of a cost-benefit analysis recognising that the incremental cost of protection was economically insupportable.

Similar decisions are made routinely in Whitehall, yet the public perception of official ineptitude persists. Ministers often think the public should be protected from the media, presupposing an extremely low level of media literacy. Select committees and the Public Accounts Committee regularly cite instances of officials who set out with brave intentions of what they want to do to manage risk in society and policy



Rick Haythornthwaite is Chair of the Better Regulation Commission. He is also Managing Director at Star Capital Partners Limited and Non-

Executive Chair of the Board at Mastercard International. He started his career with BP. He read geology at the Queen's College Oxford and subsequently took a Sloan Masters in Business Management at Massachusetts Institute of Technology.

making, yet who find themselves isolated as select committees seek an accountable individual. Not surprising, then, that officials are by and large risk-averse. The Commission challenges this attitude. We recognise the 'something must be done' syndrome. We can all cite instances when the Government has reacted in a kneejerk fashion, producing bad legislation that has led to unintended consequences and further layers of regulation.

The 'wi-fi' issue is a current example: a newspaper raises the issue, we hear of people who may have been made ill by wi-fi, scientists theorise and industry groups add their views. Suddenly, we have a mass of one-sided opinions competing for an audience. This is when the Government needs to stand firm and ask for a systematic review of what is happening.

On the one hand, in this blame culture where people seek less risk in their lives, they ask Government to legislate to exclude risk. On the other hand, they lament the loss of a self-reliant, spirit-ofadventure society. Government allows these two views to exist, so it is no wonder that we get ourselves into difficulties. Government must emphasise that having zero risk is an undesirable and unachievable state in society. If an individual understands the risk, can afford to mitigate it and is doing no harm to others, that risk should be left with the individual.

We have asked the Government to lead

Rick Haythornthwaite

a campaign against inconsistencies and absurdities. Poor policy is often driven not by a desire to purge risk from the lives of individuals, but by inconsistencies in layers of regulation from the past. The Government has responded favourably, recognising that policy makers should reflect on this issue. It is key, both to simplifying the flow of regulation and, more importantly, to reviewing the existing stock.

The Commission focused attention on three areas. First, we wanted to ensure that we do not simply think interventions always justify the opportunity cost. It is difficult for ministers to remove protections; examples are rare. The Department of Transport takes a wide view in some areas as to the definition of success. For example, in the matter of death from motorcycle accidents, it makes it clear that helmets must be worn, but in the pursuit of broader enjoyment choices on protective clothing are left to individuals. Contrast that with the Department for Culture, Media and Sport on football stadium safety. They have only one aim - the safety of individuals in the ground - which leads to a rigid policy regarding all-seat stadiums.

By asking how broad the measures of success should be, a different view emerges of the risks that can be tolerated in the relationship with society as a whole. Equally, we asked officials to look more systematically at some of the issues raised.

Our second priority was to ask, in a number of areas, how we can regulate in a more targeted fashion. We have different possibilities at our disposal, including new technologies, but one could go back to many regulations and ask, if trust-based relationships and *caveat emptor* were inserted, who would truly be at risk? Perhaps there are ways to protect vulnerable communities without regulating in a way that affects everyone. By challenging departments, we expect to identify opportunities for simplification and a shift of responsibility for risk back towards individuals.

The third priority area is drawn from my own experience in dealing with officials. Policy-making culture has struggled to adjust from a world where, for example, we were solving public health

managing risk

issues in the Victorian era simply by putting in new sewers, to dealing with today's highly complex behavioural systems where it is almost impossible to get it right first time.

Today, any changes that are made will probably be greeted by accusations of a Government U-turn and 'Why can't the Government get it right first time?' headlines. It is, thus, unsurprising that officials are reluctant to trial, learn and adapt. There must be space for them to act more adventurously, leading to more effective policy-making in complex systems.

The Commission has touched on this by considering, for example, the shift in the behaviour of householders regarding energy management. There was uproar about Home Information Packs and energy performance certificates. The principle may be good, but we have seen no evidence for or against it. We see only a history of failures to modify the behaviour of individuals in their homes in terms of their energy use, and no clear indications that we have learnt from past experience. Another layer of regulation has been heaped on the past.

We have sought to start a debate. It is incumbent on us all to demand leadership at important moments. We have to ask the Government to reinforce the position that the individual counts, and is capable of carrying far more risk in

society than perhaps they have been allowed in the past. We have to press for a systematic look at risk, for far more debate about the trade-offs. We need a recognition that regulation is not free and resist the siren-call that 'something must be done'

Do we want a society where people have forgotten how to manage risk and have foregone the enriching opportunity to learn from the management of risk? We do not believe that would be a better society.

Risk, Responsibility, Regulation: Whose Risk Is It Anyway? is available at: www.brc.gov.uk/ publications/risk_report.aspx

Risk management: an audit of Government

etween 2002 and 2004 I ran a programme to improve risk management in Government, arising from the Number 10 Strategy Unit Report on Risk. The report identified a paradox: on the one hand, we have a risk-averse public service. On the other, Government tends towards risk-blindness, plunging into large and expensive programmes and complex policy developments without prior consideration of the risks involved.

We considered how to improve risk management by Government departments. The classic definition of risk is 'probability times outcome'; but we need to remember that the outcomes can be positive as well as negative. A reminder of this is the business maxim, 'no risk, no profit'. We think of risks as bad things, but they are not harmful in themselves. It is a question of: 'Can you manage the risks in implementing a course of action sensibly, avoiding catastrophes?'

Expectations of Government are higher than ever before. The Strategy Unit Report identified high (often unrealistic) expectations of what Government could deliver by way of improvements in public services. We ran a two-year programme, examining how departments were run and how the risks associated with the delivery of programmes could be better managed. We took into account private sector practice such as the role of audit and risk committees in the commercial world and statements of internal control: some of this formalism may have been overdone in the commercial sector as a result of scandals like Enron, but nonetheless some of the findings of good



Sir David Omand GCB, Visiting Professor at the War Studies Department, King's College, London, retired in 2005 after over 35 years in the Civil Service. He was the first UK Security and

Intelligence Coordinator while Permanent Secretary in the Cabinet Office and was the Government's chief crisis manager for civil contingencies. He led the interdepartmental initiative to improve risk management across Whitehall and was Permanent Secretary of the Home Office from 1997 to 2000.

business practice could be applied in government.

A role for non-executives

Non-executives could play a bigger role in Government departments, monitoring the risks of the policies that the executive was launching into - just as a non-executive would, on behalf of the shareholders, monitor what the executive of a company was doing. All Government departments now have such management boards with non-executive members.

When we started this work we had recently suffered the 'three Fs': floods, foot-and-mouth and the fuel dispute. These revealed that the nation had no effective post-Cold War arrangements for

David Omand

managing civil emergencies. By making officials aware that they were in fact dealing with risk management on a national scale, we would also sensitise them to the need to improve their general management performance.

But how to get officials interested? One traditional way has been to pose a threat; no-one enjoys being humiliated in front of the Public Accounts Committee. That has a negative tone: too much constant criticism leads to risk-aversion. On the other hand, nobody wants to find themselves the one in charge when things go wrong. The positive message is that you can stop things going wrong by getting a grip on the issues early through good risk management.

There was thus no lack of interest in Whitehall. We had support from the top, with the Prime Minister, Chancellor and the Chief Secretary firmly committed. We were, however, conscious that Government departments vary greatly in size, shape and role and we had to appreciate that different departments were at different stages of development.

All our papers on risk management and the programme are open to the public via the web (www.hm-treasury.gov.uk/documents/public_spending_reporting/governance_risk/psr_governance_risk_riskguidance.cfm or Google 'HM Treasury and Risk'). We formed alliances with other initiatives, in areas such as project management improvement and crisis management. We asked the National Audit Office to examine independently whether our work had made a difference.

We also produced clear guidance

managing risk

Trust and transparency. People would be more likely to accept risk if Government

discussion

were better at communicating the nature of risks and explaining why some must be accepted while others could be subject to regulation. But successful communication of the nature of risk in policies depends on the public trusting the Government to be open and honest about them. Transparency and openness are crucial. Secrecy is corrosive - immediately someone feels they are not being given the whole truth, all trust disappears. This is particularly true in relation to concerns about terrorism, where it is essential to enlist the support and understanding of the public in dealing with insidious and unknowable threats.

for those debating these tricky issues of risk with the media and with the public. Paradoxically, we found that media and the public were more likely to believe advice on risk the further away from the Government the individuals giving the advice were. Examples were the Bank of England Monetary Policy Committee and the Food Standards Agency. Should the lesson be to push risk management decisions as far away from Government as possible? While the public might be more likely to accept the decisions thus made, any such trend would further distance democratically-elected representatives from the public that elects them.

Another concern of ours was to get away from the 'tick-box' attitude. If we ended up with an elaborate system with senior levels just ticking the box 'Yes, we have a control statement' and the job of risk management being considered done, then nothing would really change at the levels where day-to-day decisions affecting the public are made..

A matrix approach

We tried to get away from simply relying on documents such as risk registers, suggesting individual departments and agencies complete a matrix to evaluate three classes of risk, by both probability and impact. The first group of risks are those over which the organisation has little or no control but which may impact heavily on operations (for example terrorism or flooding). Senior management needs to know that adequate business continuity plans and mitigation strategies are in place. The second group of risk are those inherent in the nature of the business (such as prison escapes for the Prisons Agency). Here senior management needs to know that there is a properly audited process of assurance. Finally, and most importantly, there are self-inflicted risks. These are the new IT projects, or new sets of policies, on which the Board has embarked and on which the reputation of the department, and possibly the government, rests. Here senior management needs to keep close to the programme managers and ensure that the quality of

managers and the resources allocated are appropriate.

The Government now maintains a matrix of all the serious hazards and threats faced by the UK. It has over 100 entries, each weighted according to impact and probability. It guides the allocation of resources, for example which vaccines are stockpiled or which exercises are run to test different scenarios. It will never be perfect, but it is a systematic way of working out what are the major risks facing us and how they are managed.

Poor risk management leads to certain kinds of behaviour. You can enter an organisation and know quickly if it is behaving in that way: people keep their heads down, fighting each other instead of fighting for the common cause and denying rather than identifying problems before they become critical. Get risk management right, on the other hand, and you can identify the risks early, see when they become opportunities, prioritise the issues on which senior management should focus on and thus continually improve performance. Confidence then breeds trust and you get better at it in a virtuous upward spiral.

We coined two phrases in particular. One was 'a safe space'. I asked Government departments if there was a 'safe space' in which the boss (or the boss plus a small team) can talk with ministers and each side tell the truth to each other. In the security of this safe space, nobody loses face by saying that something is a bad idea, and the minister can equally speak frankly about the shortcomings of the department without creating a general crisis of confidence. In my experience, such conditions for constructive frankness are unfortunately rare.

The other phrase we coined concerned who was in the room when the decision was taken: 'who had a seat at the table?' Were only ministers and special advisers present to discuss the development of a policy? Was anyone there actually responsible for implementing the decision? Were they asked what it would take to implement it?

As I mentioned, an early decision we took was to have ourselves audited. In crude terms we saw four levels of competence in risk management. Most Government departments, when we started, did not know they had a problem – they were at the first level, 'unconsciously incompetent'. Pretty quickly, people began to realise it was something they had to work on: they were now at the second level of 'conscious incompetence'.

By the time we had finished, the National Audit Office reckoned that almost every department was reasonably competent, the third level of 'conscious competence'; that is, they had to make a conscious effort to keep managers up to the mark in considering risk. A few organisations had progressed to the point where they were 'unconsciously competent'; they did not have to think about it, they just did it, unselfconsciously.

We set up a risk network, inviting each department to appoint a young official who was assertive and would be a champion and help spread best practice. They were also our whistle-blowers who would tell us if, despite fine rhetoric, nothing was happening in their departments: then we would intervene. We had self-assessments as we went along and we submitted formal reports regularly to the Prime Minister and were assessed independently by the NAO at the end.

What general lessons can we draw from this experience? We found that it is possible to promote change in a systematic way. It was proving possible to embed risk analysis in Government departments and, when properly applied to policy and delivery issues alike, this can make Government decisions more generally accepted by the public.

The Strategy Unit Report on Risk is available at: www.cabinetoffice.gov.uk/strategy.downloads/su/risk/report/downloads/su-risk.pdf

Verena Ross, Director, Strategy

financial services authority

and Risk Division at the Financial Services Authority, also spoke at this meeting. Her presentation and the link to her talk can be found on the Foundation website at www.foundation.org.uk - scroll down to 9 May 2007. The speech is at: www.fsa.gov.uk/pages/Library/Communication/speeches/2007/0509_vr.shtml

biofuels

Biofuels are being heralded as the 'green alternative' to conventional fossil fuels. But is it that simple? A meeting of the Foundation on 23 May 2007 considered the evidence.

The good, the bad and the not so bad

B iofuels are derived from animal or vegetable material. They can have much lower $CO_2(F)$ emissions per unit of energy than fossil fuels: the 'F' indicates 'fossil CO_2 ' – the CO_2 that is trapped and stored inside the earth before being released into the atmosphere. It differs from atmospheric CO_2 , which is naturally recycled by plants and animals during respiration. $CO_2(F)$ is the focus of environmental concern.

Currently, biofuels are the only practical alternative to liquid fossil fuels for transport. Biofuels can also be used for a range of other purposes. They are odourless, biodegradable and hygroscopic (take up water). They have lower levels of particulates and emit much less sulphur dioxide than conventional fossil fuels. In addition, they have very good lubricant properties, blend well and can be used – to a limited extent – in most types of engines.

The two main biofuels that we make are: ethanol, which is blended with petrol; and biodiesel, which is blended with conventional diesel. These biofuels can be twice as expensive as conventional mineral fuels.

Liquid biofuels have traditionally been manufactured by one of two methods. In the first, raw materials such as cane sugar, corn and sugar beet are fermented and distilled (as in the manufacture of whisky) to produce ethanol for blending in petrol.



The Lord Oxburgh KBE FRS HonFREng is Chairman of D1 Oils. His background is in geology/geophysics.

After a time as President of Queens' College Cambridge, he became Chief Scientific Adviser to the Ministry of Defence and subsequently Rector of Imperial College. He is a Fellow of the Royal Society and an Honorary Fellow of the Royal Academy of Engineering and for four years chaired the Science and Technology Select Committee of the House of Lords.

The second method is to crush oily seeds such as palm, soy or rape. After refining, this produces a diesel fuel. The fuels made using these methods are termed 'first-generation biofuels'.

It is important to note that the raw materials used to produce first-generation biofuels are traded commodities with other uses. For example, much of the corn traditionally grown as a food crop in the United States is now being diverted to the manufacture of biofuel (ethanol), and this has had an impact on food prices. In addition, a significant amount of energy goes into cultivating, fertilising, harvesting and



Figure 1. Carbon cost (energy ratio) of corn ethanol, a first-generation biofuel, compared with cellulose ethanol, a second-generation fuel.

Ron Oxburgh

processing these raw materials. Thus, the amount of energy needed to produce the fuel can be almost as much as the fuel will provide. This is clearly inefficient and is the result of perverse agricultural subsidies.

Newer ways of manufacturing biofuels ('second-generation biofuels') require only one-tenth of the energy provided by the fuel (see Figure 1). One of new techniques follows the earlier method of fermentation and distillation, but substitutes different raw materials. For example, cellulose ethanol is made using straw, a material with limited value. The process was developed by Shell and its Canadian associate Iogen, using enzymes to break down the cellulose in the straw into its constituent sugars, which are then fermented and distilled. Canadian government vehicles in Ottawa now run on a mixture of 85 per cent ethanol and 15 per cent gasoline.

Another way of producing secondgeneration biofuels also follows a traditional method - crushing seeds - but does not involve an edible raw material. Hardy inedible plants, such as jatropha, algae and other materials, are candidates for this method. Jatropha is a wild tree found in tropical and subtropical areas of central America, Africa and India, on land where few other crops can be grown. It produces fruit containing black kernels that can be crushed to produce an inedible, combustible oil. Jatropha lies at the heart of our work at D1 Oils and is, in our view, likely to be the most sustainable source of biodiesel.

Finally, a third way of producing biofuels is gasification. This method has been available for a relatively long time, but has not yet been applied to any great extent in the production of biofuels. Gasification begins with the heating of plant material of any kind to high temperatures in a controlled atmosphere. This produces a gaseous mixture that includes H_2 and CO from which petrol, diesel or, in principle, kerosene may be synthesised.

To sum up, all biofuels are not the same. While the carbon footprint of ethanol produced from corn is little different from that of unleaded petrol, that of Shell/Iogen's cellulose ethanol is much smaller. In future, materials such as jatropha will seek to match this in the production of biodiesel.□

Preserving agricultural diversity: the role of second-generation biofuels

Howard Dalton

he 2006 Stern Review Report on the Economics of Climate Change clearly pointed out the problems we will face if we continue to produce carbon dioxide and other greenhouse gas emissions at current levels. The effects will be seen in changes to our food and water supply, the functioning of ecosystems and the occurrence of extreme weather events. These are very serious issues to which we need to pay careful attention.

Although there have been gains in fuel efficiency, they have been offset by the vast increase in road traffic. Biofuels have an important role in ameliorating this and delivering carbon savings. Government calculations have indicated that if biofuel use were to reach 5 per cent by 2010, the effect would be equivalent to taking about one million cars off the road.

These calculations are based on the assumption that biofuels offer a carbon reduction of around 60 per cent. However, 'life-cycle analysis' - which looks at the entire delivery process – is a key part of achieving such a reduction. In particular, when looking at the development of crops for use in biofuel production, we need to consider the fertilis-



Sir Howard Dalton FRS is Chief Scientific Adviser at the Department for Environment, Food and Rural Affairs (Defra) and Professor of Microbiology at the Department of Biological Sciences, University of Warwick. He was elected a Fellow of the Royal Society in 1993 and was awarded the Society's Leeuwenhoek Medal in 2000. He was also president of the Society for General Microbiology from 1997 to 2000.

er requirement. The importance of fertiliser was highlighted in a recent project the Department for Environment, Food and Rural Affairs (Defra) carried out to determine the cost of milk production. This showed that the major energy cost was not transport, storage or packaging; it was the production of fertiliser for use in animal feed. This example illustrates that there are many factors to be taken into account when evaluating the energy



Figure 1. Recent emissions and future projections.

expenditure involved in producing biofuels.

The processes involved in producing biofuels such as bioethanol and biodiesel are well established. Although the UK is not producing very much biofuel at present, a plant is being built in Teesside with the capacity to produce over 400 million litres annually, using wheat as the raw material.

First-generation biofuel production puts pressure on agricultural land. Competition with food supplies means that large-scale replacement of conventional transport fuels with biofuels is not viable at this stage. However, second-generation biofuels produced from materials such as Miscanthus have the potential to yield significant benefits over their first-generation predecessors. They are produced from non-food, lignocellulosic biomass (formed from the woody cell walls of plants) that can be grown rapidly and in large quantities, requiring minimal fertilisation and water, thereby resulting in minimal soil erosion. In addition, some of their waste materials can also be utilised.

The technology needed to produce second-generation biofuels relies on the release of monomers from the polymers within plants and is currently prohibitively expensive to carry out on a commercial scale. However, projections by BP show that, within 10 years, the technology will have advanced to the point where overall costs will be reduced.

In terms of providing the raw material needed for biofuel production, the key challenge is to increase crop yield without increasing energy input. We also need to devise much more efficient mechanisms for converting the carbon dioxide utilised by plants unto useable energy. In other words, we need to develop a sustainable process.

Although carbon savings are clearly very important, sustainability is equally vital. We know that we are putting far too much nitrogen and phosphorus into the environment, largely as a result of fertiliser production. We are seeing extremely high levels of nitrates in the soil and rivers, particularly in East Anglia. To avoid exacerbating this situation, and in view of problems with water supplies, we need to develop high-yield crops that require neither large amounts

biofuels

Is power generation being neglected in favour of transport? The emphasis

placed on developing liquid biofuels for transport was questioned, since bioenergy can be used more directly to generate power, with less expense and a greater reduction in carbon emissions. Reluctantly, however, it was accepted that no democratic government would try to stop people using their cars, or move all freight traffic to rail, so transport will continue to have a significant impact on carbon emissions. Because of this, biofuels must have an important role in transport fuel policy.

of fertiliser, nor high levels of irrigation. We also need to ensure that future crops are relatively disease-resistant. Oilseed rape, for example, is an important source of biodiesel but is susceptible to damage from a variety of diseases including fungi and insects. Fortunately, research in the UK has made many

discussion

advances in the understanding of these diseases and in plant genetics that should ultimately allow us to produce disease-resistant crops with minimal environmental impact. This is an area where genetic modification can make a significant difference. And it can do so in a way that is likely to be acceptable to the public, partly because of the clear benefits in terms of energy saving, and partly because these crops are not grown for human consumption.

It is possible that in the future we may be able to enjoy 100 per cent biofuel power. However, we must work toward this in an environmentally sensitive way that will preserve the biodiversity of our farmland.

Finding the way forward – a global view

he majority of bioenergy used today is generated in the developing world. I am not referring to sophisticated biofuel production plants but to the traditional basic, and often unsustainable, systems using wood fuel and agricultural residues that make up nearly half of the primary energy supply in Africa as a whole. Indeed, biomass can account for up to 90 per cent of primary energy use in some of the larger African countries.

Considering its natural resource base, the developing world also has the greatest potential to increase the use of bioenergy. Looking at the potential to the middle of this century, Europe does not even figure in the top five areas around the globe. In 2004, the total primary energy supply from bioenergy (or in IEA terms, combustible renewables and waste) was about 280 Mtoe in Africa (equivalent to about 50 per cent of Total Primary Energy Supply, TPES) and 165 Mtoe in the OECD (equivalent to 3 per cent). Projections to 2050 indicate an average potential for Africa to produce bioenergy of 198 exajoules $(EJ = 10^{18}J)$, compared with 121.5 EJ in North America. The same set of projections show that this potential increase would be largely in bioenergy derived from crops grown on what is currently agricultural land, followed by crops grown on marginal land (such as jatropha), forest residues, agricultural residues, dung and, lastly, organic waste. In addition, global production of liq-

poor pic



Ingmar Juergens is energy policy officer in the sustainable industrial policy unit of the Directorate General for Enterprise and Industry of the European Commission. He

has previously worked as bioenergy officer in the environment, climate change and bioenergy division of the Food and Agriculture Organisation of the United Nations (FAO). He was responsible for initiating the largest FAO bioenergy project supported by the German government, which analyses the bioenergy and food security nexus.

uid biofuels could expand significantly by 2025; under one set of assumptions from the 2006 level of 50,000 million litres to over 250,000 litres in 2025.

This growth in the use of biofuels has significant implications for agriculture, food security and land use. The cost of production depends not only on the type of biofuel but on the system of production and the area of the world in which it is produced. This brings us to impacts on the agricultural market. Currently, Brazil is the world leader in the cost-efficient production of ethanol. There is a very strong price correlation between sugar and ethanol, particularly

Ingmar Juergens

over the \$35 per barrel oil price level, which is more or less the break-even point for Brazilian ethanol production. However, if the 15 EU countries were to replace 10 per cent of the petroleumbased fuels they currently produce with biofuels, they would need to use a large portion of the land currently employed for cereals, oil seeds and sugar production. Clearly, this raises the question of where in the world biofuels would best be produced.

Returning to the link with the market, a simulation exercise set in the year 2030 has shown that 10 million tonnes of sugar and maize would produce 0.282 EJ of biofuel energy, but would increase the international price of sugar by 11.3 per cent and of maize by 3.4 per cent. One interesting side-effect though is that the availability of protein-enriched by-products from biofuel production would decrease their prices.

All of these factors will combine to create winners and losers from the transition to biofuels. Countries that export both energy and agricultural products will be winners; those that import both will be losers; and those that import energy but export agricultural products, or import agricultural products but export energy, will both win and lose. So, the answer to the question 'Are biofuels good or bad?' depends not only on which biofuels are being discussed, but on which country is asking the question (notwithstanding the issue of unequal

biofuels



Figure 1. Bioenergy supply in 2004 (according to IEA 2006)

effects on different groups within countries, where in particular the urban poor, even in food and energy exporting countries, could well lose out).

There is also the question of foodversus-fuel if land is taken out of food production and used for biofuels. Will there be a shortage of food? There is great deal of discussion about food security and bioenergy. In fact, though, the discussion tends not to be about 'food security', but rather about food production. The security of food supply involves issues of availability, access, stability of food systems and utilisation. So it is not a simple question of foodversus-fuel.

Energy and agriculture markets are not equal forces. Energy markets are much bigger and have led to the creation of a near-perfect elastic demand for competitive agricultural products. It should be noted that energy markets drive the relevant agricultural markets, but the reverse is not true (as long as the share of bioenergy in total energy is low).

The demand from the energy sector has created a minimum or 'floor' price for agricultural products. These will rise in line with energy prices and will not go below the floor level. However, agricultural prices will not rise faster than energy prices. Some of the scenarios painted by, among others, certain policy makers, suggest that agricultural prices can rise endlessly. Yet, if feedstock becomes too expensive then it will be priced out of the market, since at that point it would be more expensive than the reference price of the commodity with which it is competing - petroleum or other sources of energy. This means that there is also a 'ceiling' price. We will see price fluctuations only

between these floor and ceiling prices, not beyond them, at least where markets function. Where policy targets like minimum blending rates are set, this ceiling effect might be less applicable as, unless policy targets are reviewed, the demand triggered by them is not determined by price.

At the moment, we are seeing rising real prices – a commodity boom actually for rural agriculture. We are also seeing very high growth in many commodity-dependent African economies. A few words of caution here: to be wary, particularly when advising our developing country counterparts, of making large capital investments in first-generation biofuels. I believe we are very close – perhaps no more than a decade – from a total shift away from these types of biofuels. The overall impact on food secu-

watch out for bust after boom. We need

The overall impact on food security remains unclear. Certainly, urban households and resource-poor rural households stand to lose the most, but what we have to do now is establish the links between policies, markets, producers and households. The policy advice component of this is important, since policies can help to mitigate adverse effects on poor urban and rural communities, and to harness the benefits of bioenergy.

I have not touched on many of the environmental aspects of bioenergy, but they are very important. We know that the benefits of sustainable development – the development of rural areas, including the creation of energy systems in these regions – does not happen automatically. We need good business models and we need sound policies. Existing analysis has clearly over-emphasised the role of food production at the expense of other dimensions of food security.

I would like to thank my colleagues at FAO, in particular Josef Schmidhuber, for sharing their insights and contributing significantly to this presentation.

discussion

Sustainability. If biofuels are to become an important source of energy, there must

be one person in Government who will design and lead a policy that takes into account the economic, social, food security and land use issues. However, there has been no indication that the Government has seen the need to encompass all these issues together, and participants felt that there was no coherent energy policy, although the recent White Paper might improve matters. The price of carbon will be a major influence on the use of biofuels but it will not, on its own, lead to sustainable products.

The need for international policies. It would be shortsighted to consider biofuel

discussion

production and use in the UK on its own. Developing countries are likely to be the best sources in the future. Poor land could be used and jobs created (although there was some scepticism about the welcome local people might give to what they might see as another land grab by international companies). However, investment in this area is hindered by uncertainty about future national and international policies. The way ahead seems to be to exert pressure to remove perverse subsidies that hinder sustainable biofuel production, to focus public attention on the sources as well the amounts of energy we use, and to set ambitious but realistic targets for the future.

How should the Government promote innovation in the economy? This was the subject of a meeting of the Foundation held at the Royal Society on 5 June 2007.

Five habits of innovative societies

would like to set the scene with an overview of the five habits found in innovative societies. Habit One is concerned with a national, galvanising purpose. On 25 May 1961, President Kennedy stood in front of both Houses of Congress and said that the USA would put a man on the moon within 10 years. That vision, that sense of mission, unleashed thousands of small, technological innovations up and down the country. They did not directly contribute to putting a man on the moon, but they definitely emerged from that sense of mission. That national galvanising purpose has at least as much impact in fostering innovation as all the tax cuts and regulations put together.

Complacency

My view is that there is a degree of complacency in this country around the imperative of that national galvanising purpose. Consider Estonia. The OECD description of Estonia a few years ago was stark: "bankrupt, polluted and decaying".

A few years later, the world economic forum with which I am associated has described it as the most competitive EU country. This followed a massive national galvanising purpose around embedding the knowledge economy. It required a tremendous amount of political will.

Habit Two is a culture of enterprise: ingenuity, curiosity, problem solving. The innovative capacities of a country are a function of how deeply rooted that culture of enterprise is within a society – not just in a laboratory, but within companies, schools, local authorities and universities. The latest statistics in this country about fear of failure – I think it is 33 per cent – is a symptom of a much deeper malaise which has less to do with entrepreneurship and more to do with a willingness (or lack of it) to adopt new ideas and to take risks.

Habit Three concerns a society's capacity for a collaborative approach to innovation. The American sociologist Irving Janis analysed why what was arguably the greatest single American administration in history – the American administration of Kennedy in the 60s – brought the world closest to World War III through the Bay of Pigs



Jonathan Kestenbaum is Chief Executive of the National Endowment for Science, Technology and the Arts (NESTA).

NESTA is the largest single endowment in the UK exclusively dedicated to fostering innovation. With Sir Ronald Cohen, the Chairman of Apax Partners, Jonathan created the Portland Trust, which most recently developed a \$500 million fund for small and medium-sized businesses in the Middle East.

episode. Janis's conclusion was that that this administration was staffed essentially by the same type of people: men in their mid-40s from the University of Harvard. They thought in exactly the same way. And therein lies the road to what we call today group think.

Collaboration

Now we know, when it comes to fostering innovative societies, the profound impact of collaboration across institutions, across sectors, across industries, but above all else across disciplines. Richard Lester at MIT has identified how different industry sectors have been profound beneficiaries when unexpected and unusual collaborations have been assembled to solve industry problems. NESTA has recently attracted the best graduates from the Royal College of Art together with the best engineering graduates of Imperial College to give them Jonathan Kestenbaum

genuine problems to solve.

Habit Four is the role that capital plays in the innovative society. We have learned in these last 20 years the degree to which the innovative society benefits from multiple pools of capital doing different things at different stages of the investment cycle.

Catalytic impact

We should not underestimate the catalytic impact that disciplined amounts of public finance can play. Nor should we over-estimate what it can do on its own. Unless public finance is joined up in one form or another with private finance, it will not amount to very much.

Habit Five is to do with the role of science as the engine of innovation. We have learned that innovative societies tend not to get drawn into endless discussions on the relative merits of basic or applied science. These societies recognise that this is a false dichotomy. Science policy is a critical component of innovation policy and alongside the other dimensions of the innovative capacities of a country – skills policy, taxation, labour laws, and higher education – it allows innovation to flourish. The question is: to what extent do we have the Government machinery which provides for that?

So, there we have five habits. If Schumpeter is right and innovation comes in bursts which sweep away the old ways of doing things, then these five habits together give a useful prism through which we can view how fertile the ground is here in the UK for the next set of bursts to happen.

discussion

The role of Government. Government has a clear role in supporting world-class sci-

ence, which is the gateway to knowledge created elsewhere in the world. There is now a shared understanding of the drivers of innovation, but the right role for Government in fostering it is less clear, though Regional Development Agencies are well placed to promote the agenda. Government can promote innovation by identifying problems and asking business and universities to work together to solve them. There is scope to use NHS purchasing power more proactively, to counter growing competition in the pharmaceuticals market from Russia and China. The UK Biobank Project will be an important resource.

Connecting innovation and business success

Anne Glover

he Technology Strategy Board is an important initiative. It is an acknowledgement that the economy will be based in future on innovation and knowledge. The Government has invested £10 billion over the last two years in research, and the TSB itself has been allocated £350 million over that period to help move innovations from the science base into commercial reality.

It is very important that the TSB is seen as a business-orientated body. It will be the kind of innovator which uses a small amount of money to catalyse investment from other Government departments and, ultimately, businesses.

In addition to innovation platforms and collaborative R&D, it has already taken on 22 knowledge transfer networks (KTNs). These provide forums for people from specific areas in the economy to meet together with others from the science base to improve their areas. The Board is also assuming responsibility for knowledge-transfer partnerships, which again are collaborations between business and the Government at a micro-level.

These are good initiatives. However, £350 million is a drop in the ocean: we are trying to be a catalyst.

The single most important lever that the Government could use, above and beyond this kind of collaboration, is its procurement power. Departments have a spending budget of £150 billion. Contrast that figure with the £10 billion going into the research base and the £350 million that is going into the TSB. So beyond what the TSB is doing, we need to identify how Government procure-



is Chief Executive, Amadeus Capital Partners, and a member of The Technology Strategy Board. Before founding Amadeus, Anne was Chief Operating Officer of the Apax-backed company, Virtuality Group plc, which was listed on the London Stock Exchange in 1993. Anne joined the Council of the British Venture Capital Association in 1999, and was its Chairman from 2004 to 2005.

Anne Glover CBE

ment can help young, small, technology companies.

Venture capital approach

As a venture capitalist helping young companies to start up, I use a rule of thumb: a half million dollar order is worth about \$5 million in investment capital, a ratio of about 10:1. A customer's dollar brings with it a customer who is very demanding. It means that engineers work with users; they actually benefit from a feedback loop. There is a tremendous sense of satisfaction; you are no longer working in isolation and it forces a sense of pace in the organisation. There is no question in my mind that figuring out how Government procurement can be used to help small technology companies is the next important step.

In our venture capital world, a huge opportunity is emerging in a new

Models of innovation. The pressures on universities to make use of their intellectu-

discussion

al property, using a business model reinforced by performance measures and the need to generate income, have worked against early publication and free exchange of ideas – and it is these which are the real drivers of innovation. Policy has overemphasised supply side measures, drawing on an outdated linear model. Innovation is better seen as an open market, in which business will buy knowledge, but does not care where it comes from. The Government's focus should be on removing barriers, improving infrastructure, and providing regulatory frameworks. Successful measures also include the two-way exchange of people and highly-paid intermediary posts with experienced people who can set up deals.

category of investment called 'clean tech'. This refers to anything focussed on renewable energy or reducing CO₂ emissions. This has become, in the last two years, the third-largest investment category in venture capital in the United States after biotech and software; it exceeds semi-conductors. Whatever proportion of the £150 billion that Government policy could direct to pull through clean carbon technologies, please find a way to allocate some of it to UK-based businesses rather than to Silicon Valley! That is the way in which young companies will thrive.

We need to grow venture capital activity in this economy. To do that we must have success. Success breeds success, and that means building strong companies that make money and return it to investors. London is the financial capital of Europe and we need to build on that. It is even the venture capital of Europe; however, European venture capital activity is much less than in the United States.

It is less because we have not had as many successes as US industry: by success I mean outstanding successes like Google. The one obstacle to this is ambition: it is simply the level of ambition that we have, collectively, and the long-term capital available for growth. It is the ability to take companies public while still growing and sometimes while still loss-making.

The London Stock Exchange has commissioned a research report together with the Association of Investment Management. According to this, one policy change - removing stamp duty from shares - could result in GDP growth of 1/4-3/4 per cent, lower the cost of capital by 10-12 per cent, drive equity prices up by 7.25 per cent and increase tax revenues by £4 billion. Such improvements would pull through into the capital markets and increase the availability of support for spinouts and other innovation. London is one of three major financial centres. It is the only one that charges stamp duty on shares. Of the G7, it charges the highest amount of stamp duty on shares. So although it may not be popular, removing stamp duty from shares would make a huge difference to the quality of innovation that is happening here in the UK.

The role of the Research Councils in improving UK performance Peter Warry

he remit of the Research Councils is 'to improve the relative international performance of the UK research base and improve the overall innovation and performance of the UK economy, including through effective knowledge transfer amongst universities, research institutions and business'. The new Science and Technology Facilities Research Council's (STFC) Royal Charter requires it to support high quality scientific and engineering research, assist postgraduate training, promote the advancement of knowledge and technology in order to contribute to economic competitiveness, and encourage public engagement and disseminate knowledge. The Charter makes all of these goals of equal priority.

High quality

The Research Councils have always been good at fostering high quality science and research, but perhaps there could have been a greater emphasis on, and appreciation of, the economic role. Why is that important? A vibrant intellectual infrastructure is essential for a strong economy. It is the reason why companies locate to the UK and it is how we compete. It can only be delivered if the research community interacts with the wider economy.

In addition to my role on the STFC, I also wear a business hat. Speaking as a businessman, what would I like the Research Councils to do? I think there are several things. First, they should set relevant scientific priorities - and that does not mean for applied research. It means a proper balance between curiosity-driven research and relevant national goals, for example research into energy and climate change. Second, I would like them to foster the supply of trained people. From industry's point of view, I think this second goal is the most important of all. Third, we would like the Research Councils to facilitate the wider economic agenda.

To examine what else the Research Councils could do, I was asked last year to chair the Economic Impact Group. We recommended that Research Councils act on their leadership of the knowledge transfer agenda, improve the 'influencing' they did and increase their engagement with their user organisations. Following this, the Research Councils are now work-



Peter Warry FREng is Chairman of the Science and Technology Facilities Council. He is Chairman of three FTSE250 companies and was recently Chairman of the Particle Physics and Astronomy Research Council. Mr Warry was Chief Executive of Nuclear Electric when it was privatised. He is a Fellow of the Royal Academy of Engineering.

ing to establish a baseline of their actual economic impact at the moment. Each Council will then approach its stakeholders every two years and ask them, 'How well have we done?'

Merger

The Science and Technology Facilities Council has only recently been set up; it is the result of a merger between the old Particle Physics and Astronomy Research Council and the Council for the Central Laboratories Research Council. Its mission is to produce: world-class science; greater international leverage; significant economic impact; more good, trained people; improved public engagement; and effective organisation.

As far as world-class science goes, I would like to see a little more risk: this is an area where we can really make some breakthroughs. Risk is good, as Jonathan Kestenbaum and Anne Glover have both pointed out.

We would demonstrate greater international leverage by taking a clear UK position on the international facilities agenda and by forcing realistic choices amongst international partners and internally amongst ourselves. So we need to set out a UK programme and we then need to deploy that UK programme in Europe. Our goal should be to try and mould these European programmes into something that the UK wants. To date, we have not been as effective at this as we could be.

Economic impact

How would we demonstrate significant economic impact? First, by making the facilities at Harwell and Daresbury campuses self-sustaining. The Government is committed to making a real impact in these campuses. We have put the Cockcroft Accelerator Institute at Daresbury. We need more facilities there to get enough mass to enable it to be selfsustaining.

We also need to think about the provision of solutions for industry; we need to become a natural resource for problem solving and horizon scanning. We need better business engagement, more knowledge exchange and more spin-outs. We need to involve industry early in R&D for large activities: I think that is important. And we need effective partnership with the new Technology Strategy Board so that we maximise our combined impact on technology.

Highly trained people

We also need to increase the quantity of good, trained people. We would like to see a better flow of highly-trained people into industry and commerce. I would like more two-way secondments, more students working on STFC facilities, more technicians and apprentices trained in our laboratories (this I think is an equally important agenda) and a more rounded training to include project and facility management.

The aviation industry. In the aviation industry, the extension of emissions trad-

discussion

ing will have an impact; the flat rate airport duty does not. There has been little serious innovation at the lower end of the market, and the environmental debate has yet to have an impact. The development of Airbus involved fruitful collaborative research and development, but environmental targets are at present mainly self-imposed, leading to incremental improvements. There is a need for more pressure from end users.

How universities can contribute more effectively

Rod Coombs

e are all familiar with the data that suggests that Britain does not innovate as well as its competitors, and we are familiar with the arguments as to why. While there is much to commend this, it does lead us into a potential trap where we see innovation as some kind of essential characteristic which some nations possess more of, and some less. This is not completely true. However, it results in policy (which I think we are only now beginning to break out of) that for many years constructed the problem as, 'How can we get more British innovations by fixing the British innovation processes?' It was as though the problem was confined to our national borders.

We should adopt a new policy. We should stop seeing this as a British problem and instead view it as an issue of how to better integrate British innovation activity into the global innovation system. The core of this challenge is not just to improve our indigenous innovators, but to attract globally mobile innovation activities into our own marketplace.

Part of the solution lies in intervening in the size, shape and structure of our markets so that they become more like those leading innovation markets which pull innovators in. I think this should be the new centrepiece of policy innovation in the UK.

Let me now give a very quick university perspective. We have two core businesses, research and teaching, and they both operate at negative margins. Government policy has begun to address this through fees and through full economic costing, but neither of those measures fully reflect the real costs.

The need to deal with this problem is bringing us to a tipping point in the development of the British university system. We will not be able to remain as good as we are if we continue to operate with this business model, where our resources always run behind our ambitions. Some universities in Britain, in order to remain in the lead in worldclass science, will have to much more actively develop new revenue streams and at a much higher level. These new streams will be in areas like distance learning and continuous professional development (CPD).



Professor Rod Coombs is Vice-President for Innovation and Economic Development at the University of Manchester. He has international experience of innovation, technological change and commercial development. He has considerable experience with international companies as a consultant on strategic aspects of Research and Development and Technology Management. As Vice-President, Professor Coombs is responsible for commercialisation of the University's research.

I believe that we should investigate every possible way to gain maximum economic impact for Research Council spending in universities. However, let us not fall into the trap of imagining that this is an argument about the balance between applied and fundamental research.

The main benefit of research in Britain's universities is that it gives us an initial entry into international global networks and produces creative people.

That is its main economic impact. The debate about the relative size of the basic versus applied versus strategic research budgets is looking at the wrong issue. We should treat the industrial engagement of universities as an important cultural matter to be addressed by a variety of tools, not just by crude measures to do with the allocation of the Research Councils' money. We should focus on getting our universities more connected to international networks.

Finally I want to mention three specific topics where we could benefit from policy change. First, R&D tax credits are limited to a very rigid definition of R&D and do not incentivise innovation in high value-added service businesses. Second, I think it would be helpful to have a 'grace period' – as they do in the United States - on patents.

Third, we must get away from trying new recipes to make technical help from universities 'easier to access' for SMEs. Those who want it are usually able to find it. The much bigger problem is that hardly any SMEs even know that they need to innovate. So I suggest giving them a tax credit, which their accountant would force them to use, for help from the local business support agencies to carry out an audit on how the business could benefit from innovation.

discussion

Research trends. It was suggested that, while young researchers are keen

to innovate, there is pressure to publish papers and play safe. And there are very few universities who have experienced researchers in mid-career who understand the requirements of business partners. The Research Councils are taking initiatives to fill this gap; these were welcomed, as long as they do not squeeze out funding for blue skies research. There is still a need for more smart money in London, but the necessary flows of people between the science and investment communities are beginning to happen.

Summaries of the discussions and many of the speaker presentations from events organised by the Foundation for Science and Technology can be found on the website at: www.foundation.org.uk

The challenges facing UK energy supply over the coming years have been laid out - and solutions proposed – in the latest Energy White Paper. The issues were considered at a dinner/discussion organised by the Foundation on 20 June 2007.

The challenge of ensuring secure and sustainable supplies of energy

hy do we need an energy review and a White Paper when we published one only four years ago? Well, North Sea oil and gas production is declining at approximately 10 per cent a year, there are concerns about imports and security of supply, UK emissions are forecast to rise (on business as usual), and world emissions are forecast to rise by 55 per cent by 2030. This is at a time when economic growth, especially in the emerging economies, is driving up the price of oil and some instability in the oil supply market is adding a risk premium to that price. The price of oil is driving up the gas price, and the gas price is driving up the electricity price. To this we add a carbon price, so there are concerns about affordability, especially for low-income households. The White Paper responds to these challenges with two key objectives: reliable energy (to which I would add 'at competitive prices') and sustainable energy, which is not just about environmentally sustainable energy, but also socially sustainable energy, given the upward trend in our fuel poverty statistics.

Figure 1 sums up the politics of security of supply in the UK. It describes the estimated supply curve for gas in the UK market in the winter of 2006. It shows how much of our gas still comes from the North Sea (UK Continental Shelf) but also how, in that winter, we were reliant for further supply on a single interconnector, one Liquefied Natural Gas (LNG) terminal and then our storage. You can see how the costcurve rises quite steeply when you get to that point. In January 2006, demand took us to the extreme end of that curve, at 65p per therm (and actually beyond in March). With gas demand so sensitive to ambient temperature we moved up and down the right hand end of this curve during the winter, and so prices were very high and very volatile. That was a pretty testing time.

What were the lessons? We need to extend the life of the North Sea, reduce demand through energy efficiency, diversify our import and storage infrastructure and our sources of gas imports, and we need to diversify our energy supply to reduce our



Willy Rickett is Director General of the Energy Group in the Department for Business, Enterprise and Regulatory Reform. This Group deals with a wide range of energy related matters, from its production or generation to its eventual supply to the customer. He joined the civil service in 1975 and, as Assistant Secretary at the Department of Energy, took charge of the privatisation of the electricity industry at the end of the 1980s. He has also served as a director general in DETR and DfT.

reliance on gas. The challenge is to create a framework which delivers all of that.

Sustainable energy

Turning to sustainable energy, demand reduction measures like insulation and efficient heating and lighting all have negative costs per tonne of carbon saved, while measures like micro-generation and wave-generation and even offshore wind have higher costs at present. The challenge is to create a framework that drives the uptake of the most cost-effective options and drives down costs so that every option is cheaper.

Now there is no single solution to these challenges and there is no single technological fix. Government policy is that we should create a stable and predictable investment framework that tackles both market and government failures. So, security of supply means liberalising energy markets, making them competitive, open and transparent. It means better regulation, the most important example being a reform of the planning system so that regulatory consents do not get in the way of necessary, sustainable investment. It means preparing for when things go wrong, so we have been putting a lot of effort into updating our emergency plans recently. It means, for sustainable energy, a market-based solution that creates an effective carbon-price or an effective carbon market - this addresses the big market failure that Nick Stern talked about.

Willy Rickett

Stern also talked about other market failures: how the market does not deliver enough energy efficiency investment by itself and it may not deliver enough innovation or investment in R&D by itself - so those are two other strands to our policy. Finally, we need measures that target help on those most in need. That is a summary of the 600 pages that we published a month ago.

The White Paper is concerned with making this a reality. On making markets more competitive, there was a directive on liberalising the European market that requires action this summer. A further directive is being proposed regarding the powers of regulators and the unbundling of network ownership. We want to take these principles beyond the EU, into the rest of the world and into the agreement being negotiated, or to be negotiated, with the Russians. Transparency is important in competitive markets so we are pulling together the information that we, Ofgem and National Grid publish about forward projections in the market to ensure that investment decisions are properly informed. In terms of better regulation, we are doing a great deal of work on the UK Continental Shelf (UKCS) regime to assist the transactions that drive investment there, especially in the west of Shetland. The reform of the planning system will give more weight to national, strategic considerations and I have already mentioned our updating of our emergency plans.

Turning to sustainable energy: the post-2012 international climate change framework will be, to my mind, crucial. There is an agreed EU emissions reduction target, with the emissions trading scheme as the central measure for delivering it. The EU has also set some demanding targets on renewables and energy efficiency. The UK Climate Change Bill will set statutory carbon targets for the UK economy, and it sets up a committee to advise the Government and hold it to account: it will be interesting to see how that affects policy.

energy white paper



Figure 1. Security of supply and competitive prices. *Prices based on estimated opportunity costs of gas from specific sources; volumes based on actual volumes on the day. Source: NG; Heren; DTI analysis.

Addressing market failures

One of the market failures that Nick Stern talked about concerned support for technology. So we are creating a public/private partnership called the Energy Technologies Institute to increase our funding for research. We are also bringing together our support for demonstration and deployment in an Environmental Transformation Fund. This year we are launching a competition for a carbon capture and storage (CCS) demonstration project.

The White Paper contains a number of measures about decentralised or distributed energy, focussed on making the regulatory regimes simpler and providing more

clarity about the rewards. The reform of the Renewables Obligation will target our subsidy to achieve better value for money and we are launching the Road Transport Fuel Obligation to increase the use of biofuels. We are consulting on nuclear power, and on the measures that we feel are necessary to reduce the risk for people who might invest in nuclear if we decide to allow such development to proceed planning policy, safety regulation and a funding regime for back-end liabilities.

Stern also talked about energy efficiency. Incentives are important here and the scheme by which energy suppliers invest in the energy efficiency of people's homes is

a key part of our framework. The targets set for the Energy Efficiency Commitment (now renamed the Carbon Emissions Reduction Target) will double and we are going to widen the range of measures it supports. Looking further ahead, we are planning something even more radical. For larger commercial and public sector bodies that are not covered by the EU Emissions Trading Scheme, we are creating a UK emissions trading scheme.

Regulation clearly plays a part. There are some very demanding targets for vehicle fuel efficiency, especially our long term objective that average new car emissions be reduced to 100gCO₂/km. We have measures to improve the efficiency of appliances and of course the Zero Carbon Homes initiative by 2016 – which will have an interesting impact on energy supply for housing. In terms of information and advice, we are rolling out smart metering (to households within 10 years and businesses within five years) and home energy audits, or home energy performance certificates, are also an important element.

Looking at security of supply, if we can deliver everything we have discussed, we may be able to reduce gas import dependency from 80 per cent to 60 per cent. And we estimate our plans will deliver annual savings of between 23 and 33 million tonnes of carbon (MtC) in 2020.

Energy White Paper. www.dti.gov.uk/energy/ whitepaper/page39534.html Stern Review. www.hm-treasury.gov.uk/ independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm

The UK needs a market-based approach to energy policy

nergy policy is the home of clichés; however, those that say the energy debate has 'too much heat and not enough light' are probably close to the truth. The fact is that energy policy over the years has seen layer after layer of policy interventions that over time have created a complex policy environment.

These interventions have been numerous. In terms of taxation, there is the Climate Change Levy (CCL) and the Climate Change Agreements (CCAs) for energy intensive businesses. And, ironically, there is actually a lower rate of VAT for *using* energy than for *saving* energy! On top of this, there is upstream corpora-



Barry Neville is Director of Public Affairs and European Policy, Centrica plc, responsible for the Group's UK and EU public affairs activity. He has been involved in the deregulation of

the UK energy market and the opening of the gas market to competition, as well as Centrica's entry into the UK electricity and telecoms market.

tion tax, which has increased considerably over the past few years.

Barry Neville

Then there are the policy mechanisms, and this is where it does get complicated. The UK was the first country in Europe to introduce an Emissions Trading Scheme, and we now have an EU-wide scheme. I think the EU ETS is a good mechanism, based upon the sound market philosophy of reducing carbon at lower cost. Next, there is the Energy Efficiency Commitment, recently superseded by the Carbon Energy Reduction Commitment (CERT), and the Renewables Obligation (RO). Recently introduced Energy Performance Certificates (EPCs) will have to be paid for by consumers when selling

energy white paper

Changing behaviour. A number of the measures outlined in the White Paper will

discussion

require changes in patterns of individual behaviour in order to be effective. People like green policies, until they have to pay for them. The imposition of policies from national level was also seen as a disincentive. It was suggested that the more that local authorities could be empowered the better. One suggestion was that as people disliked Council tax, schemes that offered reductions in the tax in return for lowering carbon emissions might be very attractive.

their house and a Carbon Reduction Commitment (CRC) has also been placed on high energy users. There is a profusion of different mechanisms trying to achieve in broad terms a common goal: carbon reduction.

And then there is regulation, always an obvious and tempting choice when there is a lot of 'low-hanging fruit' e.g. the ability to regulate to eliminate inefficient light bulbs. So we have an 'alphabet soup': lots of mechanisms, lots of taxes, lots of regulation.

On top of that there are institutions to manage and police these mechanisms. At a European level there is a very strong European Commission, proposing directives that have a profound impact on the UK and other member states. The European Parliament has co-decision powers on most energy issues and the Council of Ministers is where the deals are done.

In the UK, there are a number of players: BERR, Defra, the Treasury, DCLG, DWP, No10, the FCO. That is nothing compared to the number of energy agencies: the Environment Agency, Energy Saving Trust, Carbon Trust, Sustainable Development Commission, OFGEM, Energywatch (which will transfer to the National Consumer Council). Then there are other groups that will actually assist policy development: the Energy Technology Institute which is new; the Environmental Transformation Fund - new; the Office for Climate Change - new; the Climate Change Committee (which will come out of the Climate Change Bill) - new; Fuel Poverty Action Group - existing; the Infrastructure Planning Commission which will possibly come out of the Planning Bill - new.

It must be asked: how efficient is all of this? Does it help or hinder the fundamental tension involved in formulating energy policy? For example, if we focus entirely on security of supply we might build lots of coal power stations because we have lots of coal reserves, but what would that do to our carbon emissions? On the other hand, if we go solely down the route of carbon savings, would we want to use the Energy Efficiency Commitment to focus on large homes that use more energy rather than smaller homes, where many fuel poor consumers live, but where there is less carbon to save?

The big issue is security of supply. I will start with gas, because we rely on it for a large amount of our power generation and heating. Indigenous gas supplies are finite, are in decline and will soon run out. Whatever measures we take to slow down the decline of North Sea, we have to adapt to this 'brave new world' of import-dependency.

We will be getting large amounts of our gas over the next decade from Norway and the Netherlands, both of whom are very reliable suppliers, and there are two big pipelines coming into the UK from these countries. Then we have the Russian question. There are obviously many concerns, some of them valid.

I would however say that 60 per cent of the world's gas reserves are within transportation distance of the EU and these reserves can access EU markets; by pipeline and as LNG. The big question is how large the gas reserves are and will they come to market? If you want, for example, to reduce future dependency on Russian gas, there are other options like the former Soviet Union states and the Middle East, but will this gas necessarily get to the market?

The next issue is transporting gas from Eastern Europe all the way across the EU. With pipelines coming through Germany, the Netherlands, Belgium, France and Italy, it is absolutely critical for there to be open access to the continental gas network. The winter before last, when we had a cold snap, the price of gas in the UK was three times that on the Dutch/ German border, but the gas did not flow – clearly an indication of market failure on the Continent.

From a UK perspective, has the market delivered? I would say it has. If you look at UK planned gas import infrastructure, it comprises £10 billion worth of infrastructure involving 21 different companies from 12 different countries. Together this is almost equal to current North Sea capacity.

What will the Energy White Paper

(EWP) give us? Well for a start it should help clear up planning obstacles with the proposed Planning Bill. Recently we applied for permission to create a Liquefied Natural Gas (LNG) terminal on Canvey Island. This was refused by the local authority on the grounds that the UK did not need it - now I would question whether they are the best people to decide the UK's LNG needs! In terms of generation, I am pleased that Government did not go for 'me too' policies with various obligations favouring different technologies, be it CHP, CCS or clean coal. I think the markets will deliver the variety of generation we need but to do so there needs to be a strong carbon price.

The Carbon Reduction Commitment was proposed in the EWP and is another market mechanism, this time for larger energy users, large hotels and retailers for example. This is preferable to a flat-rate such as the CCL; at least with a market mechanism you can trade your way out of a problem.

The Renewables Obligation is being 'tweaked' and although generally the industry would prefer to see less tweaking, I do not see how some of the very large projects could get off the ground without some reform of the existing obligation.

The Energy Efficiency Commitment has become the Carbon Emissions Reduction Target. Billions of pounds are being invested by energy supply companies in insulating homes and this will now double. The question is whether the Government will impose some kind of cap-and-trade mechanism on energy suppliers after 2011.

Whether 'smart meters' will make any difference in terms of carbon consumption remains to be seen, although available evidence would suggest it does.

The impact of the EU's 20 per cent renewable energy target could be quite profound. This is renewable energy, not just electricity. Europe as a whole will have to provide 20 per cent of all energy from renewable resources. In the UK, if this were all achieved via changes to electricity generation, it would mean renewable electricity contributing up to 34 percent of UK power generation by 2020. The real issue is whether we should view renewable energy as the primary means of saving carbon. I believe we should focus on carbon, which is the important bit, rather than just the means - which is building more renewable generation.

In conclusion, it is likely we will see some kind of consolidation in these policy mechanisms. As carbon trading takes off in the EU and internationally, this would be the logical next step. In the meantime, the policy alphabet soup will be with us for some time.

The challenges on the demand side

We are consuming energy at a great rate in the developed world, and the undeveloped economies are catching up. If the energy consumption per capita in the rising economies gets anywhere near what we are used to, then there will be real problems. What are the solutions? The following thoughts explore the demand side issues under the broad headings of Transport and Buildings.

Transport

Transport is a big issue. Aircraft travel probably has the highest profile, but road vehicles consume by far the largest amount of energy in the sector. One of the problems with road vehicles is that we love them. The number of vehicles on the road in the UK is rising inexorably and does not seem to be levelling off. At one time we thought it would stop when every family had a car, but now they have two or three. And cars have a life of 20 years or more so, even if some new 'clean' technology emerges, it will take a very long time to renew the fleet of existing vehicles.

Alternatives to traditional carbon fuels are therefore becoming popular. Hydrogen and battery powered vehicles are frequently in the press. But both have severe drawbacks. A great deal of hydrogen has to be carried by a vehicle if it is to have several hundred miles range (as we have come to expect). Arguably, the amount required is impossibly large unless we resort to cryogenics and very high pressure tanks. With batteries, the weight is a problem. Again, if 300 miles range is required, the weight is impossibly high. However, 100 miles range is a different matter which is why they could be very suitable for urban use. So maybe the answer is not batteries and not hydrogen?

Biofuels are currently very topical, but the problem here is land availability. The world has five giga hectares of land, but the amount needed to replace the fossil energy use in transport is between three and six giga hectares. The exact figures are debatable, but the order of magnitude is there. We require a huge amount of area to grow the fuel that we might use in our cars and trains. And there may be unintended consequences: if you choose the wrong sort of biofuel the orangutan's habitat may be destroyed! So is there any other way? We could all just downsize, from people carriers and 4x4s to something smaller and more economical. But we love our cars; how would the Government persuade us to do this?



Dr John Miles is a main board director at Arup Group, a global firm of design and business consultants. For the past

decade, he has been closely involved with developing business strategy for Arup and has developed experience of operating in China in the course of that activity. John has been personally involved in projects such as the ecocity at Dongtan (near Shanghai).

Buildings

Buildings consume a lot of energy. We live and work in them. The White Paper is pushing us to achieve the highest levels of the Code for Sustainable Homes which will allow us to achieve zero carbon dwellings by 2016. Technically, we can do it: there are demonstration projects running in the UK and abroad right now. We can put the same technologies into small developments, medium developments and very large developments. And we can get to zero carbon by increasing our reliance on community heating systems and community power supply systems.

At national scale, we can look at alternatives to conventional grid electricity. Biomass offers an appealing alternative. It produces far fewer CO_2 emissions than conventional fuels. But, again, land availability is a problem. If we grew perennial biomass crops on 10 per cent of the UK's arable land and 50 per cent of our set-aside or grassland, that would only produce 10 per cent of what we require annually. So we need to pursue enhanced yield techniques and genetic modification if biomass is to be anything other than a marginal contributor.

Like the car, building stock is replaced very slowly. In the UK, we build now at a rate which is something under 200,000 units a year; there are 15 million homes in this country. So is it better to build more new housing or should we retrofit the existing ones? High efficiency homes have a significant amount of embedded energy (the energy used in construction and in the building materials), although the energy consumption 'in use' is much less than with conventional structures. Because of this penalty of the embedded energy, it has been argued that it might take nearly 60 years to catch up on the energy savings which could be achieved by retrofitting existing buildings. So we should not focus only on new stock. These new houses cost a lot more too. House building in this country

John Miles

is tuned to the lowest first cost. Not many people are willing to pay that extra unless for some reason they are forced to.

Urban living is hugely complicated. If we are going to design better systems for living in future, we need an integrated approach. Arup is working on a project in China called Dongtan, an eco-city designed to minimise environmental impact. Here, 350,000 tonnes of CO₂ could be saved every year from building energy consumption compared with a conventional city. Some 400,000 tonnes of transport-related emissions could be saved through an integrated approach to city design. Now in London we cannot just change the road layout and the infrastructure if it does not suit us. Designing a greenfield city can be much easier than retrofitting an existing one. But greenfield cities provide an opportunity to explore the right answers and, hopefully, with this experience solutions to the problems of existing cities will begin to emerge.

Reducing emissions

So what are the options for the immediate future? There are some things we might do that cost little and have immediate effect. For example, a two-litre petrol car emits 14 per cent less carbon at 70 miles per hour than it does at 80mph, so we could rigorously enforce a maximum speed limit of 70mph, or even 60mph, and see an immediate benefit for no cost. Suppose the outside lane of the motorways was reserved for high speed coaches only - chauffeurdriven, double-decker, offices on wheels. They could operate from key hubs outside major cities, with fast links into the city centre. The other two lanes would have a 60mph limit which was aggressively enforced. These things require almost no technology, yet they could make a significant difference to our CO₂ output. And in the city, a return to electricity: city vehicles do not travel a long way and the technology for short-range vehicles is within our grasp. When it comes to buildings, an aggressive programme of retro-fitting could achieve significant reductions in national emissions.

But, in all of these things, there is a cost penalty. In the short-term, at current energy price levels, the cost of emission reduction policies is not self-financing. That is a big disincentive. Quite simply, in this case, the free market does not work. This is because the free market does not include damage to the environment in the short-term price of fuel. By the time it does, it may be too late. The market therefore has to be 'rigged' and the Government will have to intervene... either by taxes, incentives, or penalties. The creation of new Government departments with responsibility for science and innovation (DIUS) and business, enterprise and regulatory reform (BERR) was announced at the start of Gordon Brown's premiership. A meeting of the Foundation on 10 July considered the implications.

The framework for supporting research and innovation

Keith O'Nions

any of the objectives of the new Department of Innovation, Universities and Skills (DIUS) will be very familiar to those who knew the 'parent' departments. Sustaining and developing a world-class research base is still top of the list and I am sure everybody will be pleased to see that stated so prominently. Another is to maximise the exploitation of that research base for innovation, public good and greater economic benefit. There is no doubt that the very good settlement that we have for science and innovation is based on optimism for just that.

Raising and widening participation in higher education, though, is an inherited aim as are post-19 education and also the learning and skills agenda. There is a need to tackle the skills gap in adults, particularly in regard to equipping people with basic literacy and numeracy. And last, I think it is extremely important to increase the supply of skilled people in science, technology, engineering and mathematics.

Organisationally, John Denham is the Secretary of State, we have Ian Pearson the Minister for Science and Innovation and we have Lord Triesman as Parliamentary Under Secretary of State for Intellectual Property and Quality. Bill Rammell has a similar portfolio to his remit at DfES as Minister for Higher Education and Further Education, with David Lammy supporting those areas as Parliamentary Under Secretary of State. Ian Watmore, who was previously head of the Prime Minister's Delivery Unit (or Performance Management Delivery Unit) in the Cabinet Office, is the Permanent Secretary of the new department.

Sir David King has moved to DIUS as the Government Chief Scientific Adviser with his whole trans-departmental science and technology team intact. We have also inherited the Design Council from



Sir Keith O'Nions FRS HonFREng is Director General, Science and Innovation, at the Department for Innovation, Universities and Skills. Sir Keith has held academic positions in Oxford, where he was Head of Earth Sciences, as well as in Columbia and at Cambridge. He was Chief Scientific Adviser to the Ministry of Defence from January 2000 to July 2004. In 2006, he became the Director General of Science and Innovation when the Office of Science and Technology and the Innovation

Group were merged in the DTI.

the DTI; this was not previously part of Science and Innovation Group.

The Higher Education Directorate has moved from DfES essentially intact. In Further Education and Skills, the 19-onwards responsibilities have transferred but there is some division in that skills agenda. From DCMS we have inherited NESTA, the National Endowment for Science, Technology and the Arts: this is a very interesting acquisition.

The science budget

The Science and Innovation Group in DIUS now allocates the science budget. This is going to grow at 5.4 per cent in cash terms each year over the three year settlement period and is ring-fenced. Later this year the allocations to the seven research councils will be made on the same basis as we would have used in the DTI.

The three national academies (the Royal Society, Royal Academy of Engineering and the British Academy) will continue to receive sponsorship in the normal way. Two elements in the budget were jointly organised between HEFCE and DfES: the Higher Education Innovation Fund, worth around £120 million per year; and the Science Research Investment Fund which has been running at £500 million a

year. These are now 'under one roof' and I do not expect any change at all in the delivery of either HEIF or SRIF.

The academies and research councils all have a science and society or science engagement agenda, but there is a budget that has historically been retained within the Science and Innovation Group of about £6 million a year to fund things like the British Association and Setnet; and that will continue in the near future.

Innovation

There has been quite a lot of change on the innovation side over the past year. On the 27 June, just as the departmental structures were changing, the Technology Strategy Board became an Executive NDPB (Non Departmental Public Body); its Royal Charter came into effect on 1 July. The Board is now at Swindon, the budget has been transferred and it has an interim Director with its own accounting officer responsibilities, rather similar in terms of corporate governance to a research council. In due course the budget settlement for the Technology Strategy Board will be announced.

We have also retained responsibility for the National Measurement System. The largest proportion of its funding is for the National Physical Laboratory at Teddington, which is a 'Go-Co' (Government-owned, contractor-organised) and a key part of the innovation agenda. With the National Weights and Measures Laboratory at Teddington and a few other items in private industry, that is the National Measurement System.

DIUS makes a contribution to the British Standards Institute of about £6 million a year. The UK Intellectual Property Office is, in terms of employment, one of the largest parts of the Department; it has about 1,000 people

Eurther education and skills next 10	f5 2bn
Higher education	£9.4bn
Innovation	£0.3BN
Science	£3.4bn

Figure 1. DIUS 2007-08 programme budgets

in Newport. The British National Space Centre has also moved across.

Departmental spending

Figure 1 shows the 2007-08 programme budgets for the new Department: those for future years will not be announced until later. So the science budget is £3.4 billion this year with most going to the research councils. The innovation budget, which includes the National Measurement System and the Technology Strategy Board is around £0.3 billion.

I understand that Higher Education will have approximately £9.4 billion and the Post-19 Further Education and Skills budget is expected to be about £5.2 billion. So the new department has a total budget of around £18.3 billion. It is a small department, with almost everything

government changes

being delivered at arms' length.

There are some clear challenges and there are some clear opportunities. There is, for example, an opportunity to cement the close relationship we have had between higher education and science innovation although I do not believe that dualsupport is under threat. I do not think you can run universities without a dualsupport system. There is also a big opportunity to align the skills agenda with that of science and innovation. Most of the evidence from the UK, US and elsewhere, is that skills are a vital element in generating and delivering a long-term science and innovation programme in this country.

Department for Innovation, Universities and Skills. www.dius.gov.uk Department for Business, Enterprise and Regulatory Reform. www.berr.gov.uk Department for Children, Schools and Families. www.dcsf.gov.uk

The reorganisation: challenges and opportunities **Phil Willis**

epartmental change is hardly a new phenomenon to the science community. Indeed it appears that successive governments, or successive Prime Ministers, have wrestled with the challenge of where to put science within government, and what influence science should have within policy formation. It is unfortunate that all too often it takes some national or international disaster in order to convince politicians that science is fundamental - this certainly was the case with BSE and FMD, and increasingly with energy and the environment.

No change of departmental structures will win universal approval. All one can reasonably hope is that the proposals reflect current national as well as political priorities. Departmental change, no matter how plausible, will suffer if it is seen to be born of political expediency. Indeed many in this room will remember the almost universal condemnation of the move in 1995 to take the Office of Science and Technology out of the Office for Public Service and Science in the Cabinet Office and place it in the DTI.

By contrast, the proposal to set up



Phil Willis MP is Chairman of the House of Commons Select Committee on Science and Technology. From 1999 to 2005, he was Shadow Secretary of State for Education and Skills. He was appointed Chairman of the Select Committee after the 2005 General Election. As Chairman, he has developed a special interest in evidence based policy making, knowledge transfer leading to wealth creation and medical science. In May 2007, he was also appointed Chair of the Joint Committee on the Draft Human Tissue and Embryos Bill.

DIUS comes not from any sense of failure or political failure in the Office of Science & Innovation (OSI), but from the stark realisation that our economic, social and cultural wellbeing will depend on the UK having a stronger focus on science, innovation and skills.

It is because (a) reorganisation is not the result of failure and (b) is seen as a coherent response to a coherent challenge from business, academia and politics, that there has been almost universal support for DIUS.

It is, however, somewhat surprising that the word 'science' does not appear in the title of the new department. If science is to play such a crucial role at the heart of this department, then I think it should be proclaimed as the central focus. I think extending the title to 'The Department of Universities, Innovation, Science and Skills' would send out the stronger signal that science is central to almost every aspect of public policy.

The challenges

So what are the challenges facing DIUS? What are the issues? Let me present a few of my concerns. If all we are going to do is to reorganise departments (move chairs around on the Titanic and set them down somewhere else), then this will be a reorganisation in vain. We need to create something very new and dynamic out of this.

I start with the separation of science from business: many people in the business community have concerns about this. Having established a strong working relationship with the DTI and with the OSI there is a real concern that, in regard to the

government changes

exploitation of science, there may be a lack of connection between DIUS and BERR.

Equally, there are those who believe there will be an over-emphasis on wealth creation, to the exclusion of basic science. A more pressing concern is whether, within a ring-fenced science budget, the drive to fund translational or third-stream activity will be at the expense of basic science: my committee are very anxious to ensure sure that this does not happen.

The retention of the Technology Strategy Board and the key responsibility for delivering the Leitch agenda in DIUS create a powerful platform for a positive link between research and industry. Equally, bringing universities and the research councils together in the same department for the first time since 1992 emphasises the crucial role the universities and the basic research communities have in creating knowledge for the future economy.

Sir Keith O'Nions mentioned the issue of dual-support. Lord May has suggested that the new department might rationalise its use of resources. He was stating something obvious; if there are two different funding streams coming to the same institutions from the same source, do you need two organisations to deliver this? If this department is simply going to do the work that other departments did before without major change, then perhaps we are missing a trick. I for one want to see as much resource as possible get to the front line, rather than being used in bureaucracy.

There is little support for the view that dual-funding should be replaced, but the question should be: 'What are the advantages for retaining it rather than streamlining, if more actual resource could be made available?' Drummond Bone, the President of Universities UK, has made it clear that as far as the universities are concerned, the dualfunding mechanism should remain in place. Indeed Gordon Brown, the Prime Minister, assured the science community that dual-support would remain intact (although I always think that when a Prime Minister promises that something will remain intact, you should watch for future developments!).

Having the funding streams under one roof may seem to have huge advantages, particularly when it comes to negotiating on the Comprehensive Spending Review. However, it gives the Secretary of State unprecedented power to direct science, and I think this is something that has to be watched very carefully.

Coordinating responsibilities

I think the coordination of DIUS and DCSF (the Department for Children, Schools and Families) poses major problems. It is enormously beneficial to have two ministers with responsibilities for education and skills in the Cabinet, and therefore coordination should be easier: yet it would be naïve to believe this will be straightforward. Both departments have huge and diverse portfolios and it will be all too easy to concentrate on departmental, rather than national, priorities.

A key challenge for DIUS will be to increase the number of students studying science, technology, engineering and mathematics (STEM subjects), vital to the science and engineering agenda. Yet the mechanisms to achieve this will actually be the responsibility of DCSF. Without careful cross-departmental planning, it is not easy to see how DIUS could deliver on one of its core responsibilities. That problem is amplified when examining the changes to the further education sector which will now have two masters, two funding streams and, arguably, an ever more impatient business sector to satisfy.

Further Education, 14-19 education in schools and sixth form colleges, will now be funded by local education authorities. This is fine for traditional GCSE and A-level courses if they are simply to continue. But the new 14-19 Diplomas, aimed at improving vocational skill levels, will also be funded by LEAs, despite the fact that the courses are designed by business and require accreditation by higher education and skills institutions in order to secure progression. This was a key aim of the Leitch report, and a key responsibility for DIUS.

Just to add more confusion, the Prime Minister wants all young people to stay in education or training until 18: the expansion will inevitably happen via the vocational skills route, and the responsibility for this initiative will rest with DSCF. Meanwhile, the rest of the further education sector will be funded through the Learning and Skills Council whose own future is now seriously in doubt. I have to ask why the Higher Education Funding Council for England (HEFCE) cannot be expanded to deal with FE as well? Then we could get rid of the Learning and Skills Council altogether. For me, Skills is one of the most interesting but challenging aspects for the new Department as it will be charged with delivering the Leitch proposals, particularly the drive to achieve a 40 per cent graduate workforce by 2020. Within the OECD, out of 30 countries we are currently ranked 17th for basic skills, 20th for intermediate skills and 11th for graduate skills, so raising the skills level must be a top priority for both DIUS and DSCF.

Now, initiatives like 'Train to Gain' and 'The Skills Pledge' may persuade more employers to support their workforce with the development of skills; but will the Government have the courage to make a commitment mandatory in 2010, if voluntarism is not working? And is it really the job of our universities to meet a workforce training pledge set by the Government? Are we going to see a transformation of universities to meet a Government agenda on skills? I see some massive battles occurring around the Cabinet table in the not too distant future.

Scrutiny of science in Government

Let me conclude by raising an issue close to my own heart, and one where I have been staggered by the response of the science community. That is the scrutiny of science across Government by the Science and Technology Select Committee. One of the potential casualties of the move of the OSI to DIUS is the loss of a dedicated Science and Technology Select Committee to scrutinise not only the work of the OSI and the research councils, but the whole of Government. There will be a DIUS Select Committee, but given the wideranging responsibilities of the department (in particular, universities and skills), science scrutiny is likely to be squeezed out. Cross-cutting science scrutiny may disappear altogether.

Does it matter? After all there is a Science Committee is in the Lords, surely they could expand their remit and they could look at science across government? Well, yes it does matter: without a Committee which has specialist knowledge to question ministers on issues of space, science, marine policy, future legislation like hybrids and chimeras, or the work of the research councils, then science may lose its current sharp focus. Leitch Report. www.hm-treasury.gov.uk/

independent_reviews/leitch_review/review_ leitch_index.cfm

Staying at the forefront of innovation

ow can the new departments help Britain be a leader in the generation of new products and services? Today, the vast majority of new technologies are created by bringing together and developing capabilities which have been developed all over the world by thousands of creative people. Success lies in the way their ideas are brought together and improved. The list of examples is endless, from the hybrid car and the mobile phone, through to drug discovery and production techniques.

These developments were the result of engineers seeking solutions to practical problems and human need. They were the result of hundreds of individuals working in harmony and building upon earlier generations of technology until they developed new capabilities that were wanted in the market.

How are we going to stay in this race? The art is first to have a team of creative engineers and applied scientists who can stay at the head of the pack in terms of innovation and speed to product and who are kept in informed of the market and the business environment.

Thanks to Tony Blair's strong and enthusiastic backing of science, together with many years of knowledgeable guidance by Lord Sainsbury and Sir Keith O'Nions, as well as high quality advice from Sir David King, Britain remains second only to the USA in terms of the accepted metrics of pure science. However, our record for using this science to build or sustain industrial leadership in science-based, high-employment industries has not been strong. We are also behind our international competitors in the percentage of our most talented young who opt for careers in applied science and engineering.

The first challenge for the Brown Government, and he has wrestled with this issue for a long time, is how to emphasise applied science and engineering so that the full potential of our science can be released. We have to find the means to persuade industry to bring their R&D funding and strategic commitment up to world standards, and to reverse the decline in student uptake.



The Lord Broers FRS FREng is Chairman of the House of Lords Select Committee on Science and Technology. He played a significant role in the rise of the University

of Cambridge as a major economic force and centre of excellence for high technology: he was vice-chancellor between 1996 and 2003. He also spent nearly 20 years of his career in research with IBM in the USA.

Satisfying our need for applied science and engineering graduates is not just a matter of numbers: it is a matter of attracting our top minds to these careers. It frequently takes more intellectual power to harness new scientific ideas than it does to have the ideas in the first place.

For positive proof of what can be achieved, one only has to look at the financial sector which has attracted the brightest of our numerate youth to what is a mathematically complex world. London now competes with New York and in many aspects has become the centre of the non-US financial world. If such a flood of talented graduates had been attracted to our manufacturing industries, more would be in world-leading positions. There are of course some bright spots - the universities are contributing well as are the aerospace and perhaps the pharmaceutical sectors, and the environment for entrepreneurs and small companies has improved significantly because of changes initiated by the Treasury - but the need to sustain our large companies and to grow our small companies into large ones remains.

It is not important that we work in all industrial fields. In fact it is important that we do not – we simply do not have the resources. But in those fields in which we choose to compete I see no option but to do everything from the basic science to the modern sophisticated engineering that is required to develop and manufacture the resultant products and services. We need not do it all in the UK but we must have access to it and a good deal of control over the resources and how they are deployed. Past governments have eschewed this policy and made mistakes at both ends of the spectrum. On the one hand it has been thought that we can sustain an industry by merely manufacturing other peoples' products. Recent happenings in the automobile industry have shown us, once again, that this is rarely the case. And besides, how are we to attract the very brightest of our young to engineering if they are not to have the chance to design the world's best?

At the other end of the spectrum it has been thought that it is possible to carry out intellectual research remotely from development and manufacturing. This ignores the fact that most progress is evolutionary: if you do not practise the present process it is unlikely that you will be first to improve it. Asian countries that began with the manufacturing have rapidly built their engineering and development capabilities and are now understanding the importance of pure science. Their efforts are built upon a broadlybased pyramid of application which in the future will support and nourish pure science and not leave it isolated as is often the case in this country.

What needs to be done here is to build the pyramid underneath the science so that its potential is assured. This pyramid can only be built by industry because the resources are far too large for the universities and small companies struggle. In addition, the links between product development and innovation and efficient manufacturing should be as strong as possible. Ideally they should be within a single organisation.

It would be nonsense for a weak link to exist in an industrial company between the product innovators on the one hand and those who understand the market and have to manufacture the product on the other. Perhaps we are about to enter a nirvana of joined-up government so that it will not matter where breaks occur, but it is difficult to understand the logic of the new division of responsibilities when it comes to industry. There were many shortcomings with the old departments but I felt that these were more a matter of poor execution than a function of the wrong allocation of responsibilities.

The new departments

Department for Innovation, Universities and Skills

n a reorganisation of Government departmental structures, Prime Minister Gordon Brown announced on 28 June the formation of several new departments. Science and innovation responsibilities are now included in the same department as is oversight of the university system. However, industrial regulation is now separate.

The Department for Innovation, Universities and Skills (DIUS) has as its key responsibility "ensuring Britain has a highly-skilled workforce, a dynamic business community which seizes new technology and innovation opportunities and a worldclass science base".

This new Department brings together functions from the former Department of Trade and Industry, including responsibilities for science and innovation, with further and higher education and skills, previously part of the Department for Education and Skills.

The Department will bring together the nation's strengths in science, research, universities and colleges to build a dynamic, knowledge-based economy.

The specific role of the new Department is to:

- sustain and develop a world-class research base;
- maximise the exploitation of the research base to support innovation across all sectors of the economy;
- raise and widen participation in Higher Education;
- raise participation and attainment by young people and adults in post-16 education and learning;
- tackle the skills gap amongst adults, particularly equipping people with basic literacy and numeracy;
- increase the supply of people in science, technology, engineering and mathematics (STEM).

The Secretary of State is John Denham, Member of Parliament for Southampton Itchen since April 1992. He was first appointed as Parliamentary Under Secretary of State at the Department of Social Security in May 1997 and was later promoted to Minister of State. He then became Minister of Health until June 2001 when he was appointed Minister of State at the Home Office. He has held a cross-Government role as Minister for Children and Young People.

Ian Pearson is Minister of State for

Science and Innovation, with responsibility for the research base, the Research Councils, business and science, innovation, the Technology Strategy Board, the Energy Technologies Institute, the British National Space Centre, the National Weights and Measures Laboratory, the Design Council and the Commission for Environmental Markets and Economic Performance. He is also responsible for liaison with the Department for Business, Enterprise and Regulatory Reform (BERR) and the Department for Culture, Media and Sport (DCMS) - as he also has responsibility for the National Endowment for Science, Technology and the Arts (NESTA). Ian Pearson was previously Minister of State for Climate Change and Environment in the Department of Environment, Food and Rural Affairs (Defra).

Bill Rammell is Minister of State, Lifelong Learning, Further and Higher Education. Among other responsibilities, his role includes: Further Education strategy and implementation; Higher Education strategy and implementation; employer engagement in Higher Education; HEFCE; and liaison between further and higher education.

Among the responsibilities of Lord Triesman, Under Secretary of State for Intellectual Property and Quality, are: quality assurance of Higher Education; the UK Intellectual Property Office; the Research Assessment Exercise (RAE); and better regulation.

David Lammy is also an Under Secretary of State with responsibility for the Government's Skills agenda.

Ian Watmore is the Permanent Secretary. Previously, he was in the Cabinet Office where he was the head of the Prime Minister's Delivery Unit, the Government's Chief Information Officer, and the first head of the Government Information Technology profession. He joined the Civil Service in September 2004 after a 24- year business career in IT.

Department for Business, Enterprise & Regulatory Reform

This Department leads Government work to create the conditions for business success through competitive and flexible markets that create value for businesses, consumers and employees. It drives regulatory reform, and works across Government and with the regions to raise levels of UK productivity. BERR is also the lead department for making sustainable improvements in the economic performance of the regions. It is jointly responsible, with the Department for International Development (DFID) and the Foreign & Commonwealth Office (FCO) respectively for trade policy, and trade promotion and inward investment.

The Secretary of State is John Hutton who was previously Secretary of State for Work and Pensions. Malcolm Wicks returns to his role of Minister of State for Energy after eight months as Minister of State for Science and Innovation. He has responsibility for energy policy, including sustainability, security of supply and nuclear security.

Stephen Timms becomes Minister of State for Competitiveness, which includes oversight of a number of business sectors including e-commerce, communications and information industries, bioscience, pharmaceuticals, chemicals and manufacturing.

The Department will provide support to the new Business Council for Britain. The Council, made up of senior business leaders, will assist the Government in putting in place the right strategy to promote the longterm health of the UK economy.

Department for Children, Schools and Families

The new Department for Children, Schools and Families (DCSF) will focus on raising standards so that more children and young people reach expected levels, lifting more children out of poverty and re-engaging disaffected young people. In addition to its direct responsibilities, the department will lead work across Government to improve outcomes for children, including work on children's health and child poverty.

The Secretary of State is Ed Balls, previously the Economic Secretary to the Treasury. Jim Knight, the Minister of State for Schools and Learners, will have special responsibility for raising school standards (including public examinations), the National Curriculum, 14-19 education and Diplomas.

www.dius.gov.uk www.berr.gov.uk www.dcfs.gov.uk

The Foundation is grateful to the following companies, departments, research bodies and charities for their support for the dinner/discussion programme.

Advanced Research Advisory Group, Defence Academy, MoD Advantage West Midlands Aerial Group Ltd ALSTOM Areva T&D (UK) ARM Arts and Humanities Research Council Association for Science Education Association of the British Pharmaceutical Industry Astra Zeneca BAE SYSTEMS Baker Tilly Biotechnology and Biological Sciences Research Council Blackwell Publishing ΒP BRIT British Antarctic Survey British Computer Society British Council, Science Section British Geological Survey British Library British Maritime Technology Brunel University BT Group **CABI** Bioscience Calderwood Han Limited Cambridge MIT Institute Cancer Research UK Carron Energy Chartered Management Institute CIRIA (Construction Industry Research & Information Association) City & Guilds London Institute City Centre for Charity Effectiveness Trust Comino Foundation Council for Industry & Higher Education Council of Heads of Medical Schools Council for Science and Technology, DIUS CPNI David Leon Partnership Deloitte Department for Business, Enterprise and Regulatory Reform (BERR) Department for Environment, Food and Rural Affairs Department for Innovation, Universities and Skills Department for International Development Department for Transport Department of Health E.ON UK Economic and Social Research Council Engineering and Physical Sciences Research Council Engineering and Technology Board Environment Agency Foreign and Commonwealth Office, Science Section Gatsby Foundation GlaxoSmithKline

Harley Street Holdings Heads of University Biological Sciences (HUBS) Health Protection Agency Higher Education Funding Council for England Home Office Hospital Saturday Fund House of Lords Select Committee on Science & Technology HR Wallingford IBD IBM (UK) Ltd Imperial College London Inforenz Ltd Innovation Norway Institute for Statecraft and Governance Institute of Biology Institute of Physics Institution of Civil Engineers Institution of Engineering and Technology Institution of Mechanical Engineers Institution of Structural Engineers Japan Society for the Promotion of Science Johnson Matthey King's College London kmc international Kohn Foundation Lloyd's Lloyd's Register London Development Agency London School of Hygiene & Tropical Medicine London South Bank University Medical Research Council Mewburn Ellis LLP Michael John Trust Middlesex University Ministry of Defence Napier University National Endowment for Sciences, Technology and the Arts (NESTA) National Grid Transco National Physical Laboratory Natural Environment Research Council Natural History Museum Newcastle University NIMTECH North East Science & Industry Council Nottingham Trent University Nuclear Industry Association Ordnance Survey Oxford Innovation Parliamentary Office of Science and Technology Peter Brett Associates Pitchill Consulting Ponds Associates Premmit Associates Limited **OinetiO** Queen Mary, University of London Red Gate Software

Research Councils UK (RCUK) **Risk Solutions** Rolls-Royce Royal Botanic Gardens, Kew Royal Holloway, University of London Royal Society of Chemistry Royal Statistical Society Science and Technology Facilities Council Science & Technology Policy Research (SPRU) Science Media Centre Scottish Government Scottish Funding Council for Further and Higher Education Segal Quince Wicksteed Ltd SEMTA Sharp Laboratories of Europe Ltd Sir William Francis CBE FREng Smallpeice Trust South East England Development Agency STEMNET Technology Strategy Board The British Academy The Learning Grid The Leverhulme Trust The Open University The Royal Academy of Engineering The Royal Commission for the Exhibition of 1851 The Royal Commission on Environmental Pollution The Roval Society The Royal Society of Edinburgh The Wellcome Trust University College London University of Aberdeen University of Birmingham University of Bristol University of Cambridge University of Cardiff University of Dundee University of Durham University of East Anglia University of Edinburgh University of Glasgow University of Hertfordshire University of Hull University of Keele University of Kent University of Leeds University of Leicester University of Liverpool University of Loughborough University of Manchester University of Nottingham University of Reading University of Southampton University of Surrey University of Sussex University of Teesside University of Ulster University of Warwick University of Westminster Winsafe

The Foundation for Science and Technology 10 Carlton House Terrace London SW1Y 5AH

Telephone: 020 7321 2220 **Fax:** 020 7321 2221 **e-mail:** fstjournal@foundation.org.uk

www.foundation.org.uk

